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ABSTRACT

The purpose of this book is to provide building blocks for designing and reviewing environmental education programs and activities. This handbook provides 600 basic concepts needed to attain the environmental education goals outlined at the Tbilisi, USSR, conference and generally agreed to be the fundamental core of quality environmental education: knowledge, attitudes, motivation, commitment, and skill. Sections classified are: (1) "Natural Systems" containing general, abiotic components, biotic components, processes, and biological systems; (2) "Resources" including natural resources, abiotic resources, biotic resources, and degradation of resource bases; and (3) "Human Systems" including humans and environment, technological systems, social systems, and environmental awareness and protection. Each concept has its concept number, level (introductory, intermediate, or advanced), class (definition, fact, issue, or opinion), and secondary reference. A chart showing each concept's level, class, and objective (awareness, knowledge, attitude, and participation) is given. Bibliography of sources and index are provided. (YF)

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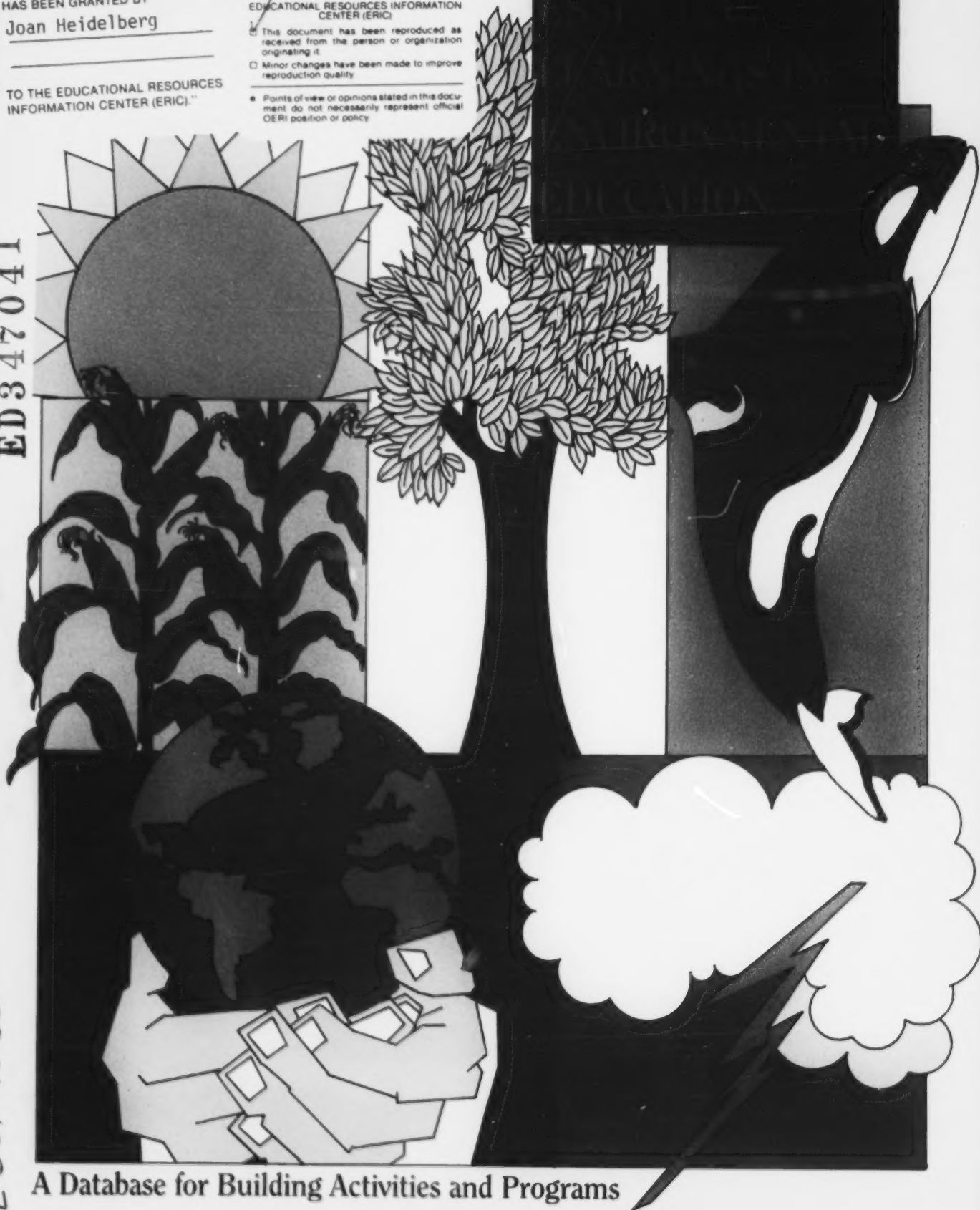
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A Database for Building Activities and Programs

ESSENTIAL LEARNINGS IN ENVIRONMENTAL EDUCATION

a database for building activities and programs



**North American Association
for Environmental Education**

Developed by

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and

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a database for building activities and programs

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About the handbook

The 1977 Intergovernmental Conference on Environmental Education in Tbilisi, USSR, set forth a challenge to environmental educators around the world: To develop a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitment and skills to work individually and collectively toward solutions of current problems and the prevention of new ones.

In working toward this goal, the Centre for Environment Education, Ahmedabad, India (CEE) and the State University of New York, College of Environmental Science & Forestry, Syracuse, New York, USA (CESF) have engaged in a cooperative project to develop a series of half-hour environmental education television programs with supporting teacher guides and student activity materials.

The series is targeted for middle school students. It is our intent to make the products of this project available to other environmental educators who can use them to further the Tbilisi Conference goals.

This handbook consists of concepts (i.e., information in various forms) we view as essential for "environmental literacy." The handbook evolved from a computer database developed as a first step in the project. The database format and first round of entries were developed at CESF between September 1986 and January 1987; a team of CEE staff then continued the project, making numerous additions and editorial changes over the next two years. Throughout its development, the database has been thoroughly reviewed by experts from diverse fields.

Our goal was to arrive at a collection that, viewed in its entirety, adequately prepares tomorrow's citizens to deal personally and collectively with the environmental issues they will face. We have attempted to be comprehensive, but there are sure to be gaps in content. And while measures have been taken to verify facts, there may be inaccuracies. Some concepts may be found misleading or biased. We expect and encourage contributions, criticisms and suggestions from users of the handbook.

Through an arrangement with the North American Association for Environmental Education (NAEE), this edition of the handbook has been prepared especially for North American publication. NAEE members have expressed continued interest in the database, and it is hoped that this handbook will meet their particular needs

for environmental curriculum development. Essential Learnings is also available on 3.5" disk for Macintosh computers, and should be on EcoNet some time in 1990. Inquiries about obtaining the database on disk should be addressed to NAEF.

While an activity of this nature can never be considered complete and finished, we hope that *Essential Learnings in Environmental Education* will be useful for anyone working to develop basic environmental literacy.

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Educator's guide to the handbook

This handbook is intended to provide "building blocks" for designing and reviewing environmental education programs and activities. Educators in both formal and non-formal settings can draw on the contents to develop educational activities that teach concepts previously determined to be important for understanding a particular topic. The completeness and conceptual integrity of existing environmental education materials can also be assessed using the handbook.

USES FOR THE HANDBOOK

Designing Activities

The *Essential Learnings* handbook can be a key tool in designing educational activities that effectively teach about the environment. Environmental education is by definition interdisciplinary, and it is important that EE programs take into account the many angles that comprise any specific question or issue. By using the predetermined concepts in this handbook, educators can be assured of preparing teaching activities that consider several perspectives on a chosen topic, and that are thorough in their approach.

Essential Learnings also encapsulates the basic concepts needed to attain the EE goals outlined at the Tbilisi conference and generally agreed to be the fundamental core of quality environmental education: knowledge, attitudes, motivation, commitment and skill. With this handbook, educators can ensure that their lessons will help their students move from awareness to action, and to gain the skills and understandings necessary for environmental literacy.

Essential Learnings contains basic concepts that experts have agreed are necessary to form a solid understanding of the environment. This database and its varying categories can help educators develop activities that are appropriate to the age or grade levels of their students, that move from basic to more complex ideas, and that build on knowledge to inspire positive environmental action.

In designing a new program, educators on all levels must begin with a general theme indicating what they intend to teach, e.g., "recycling" or "the water cycle."

Essential Learnings saves the hard work of determining *what* to teach about these broad ideas by breaking them down into their component concepts and identifying the level at which these concepts can be taught. Understandings that must precede other, more complex information are identified for the educator, as are the educational goals such understandings will achieve.

The section below on **using the handbook** illustrates how *Essential Learnings* might be used to build a foundation for environmentally sound teaching activities. A **sample search** then shows how educators might hone in on ideas to be conveyed to a specific audience for a specific educational purpose.

Reviewing Existing Materials

The handbook can also serve as a measuring stick to gauge the thoroughness and accuracy of existing lesson plans and curricula. *Essential Learnings* can help educators assess whether the goals and objectives achieved by their existing materials present a complete and age-appropriate view of a given topic. Steps for using the handbook to review materials are similar to those for material development, as explained below.

USING THE HANDBOOK

Step 1: Search For Relevant Concepts

Using the features of the handbook described below, look for those concepts that may be useful for teaching your topic(s).

Table of contents

Use the **table of contents** to scan **section**, **subsection** and **category** headings to find entries under general topics.

- **Sections:** The database is divided into three main sections: A) Natural Systems; B) Resources; and C) Human Systems. Each section contains four or five subsections and approximately 200 concepts.
- **Subsections:** Thirteen subsections comprise the three main sections of the handbook. Subsections break the handbook into manageable portions (about 50 concepts each) that can be drawn upon for creating learning materials.

- **Categories:** Subsections are further divided into 43 categories. Categories usually contain from ten to 20 concepts, arranged in general order from basic to more complex. (It should be noted that many concepts contain more than one idea, and their placement into specific categories is often subjective based on the editors' views of primary content.)
- **Concepts:** The ultimate division of the database is into the concepts themselves. There are 600 individual entries, each coded and cross-referenced according to the criteria mentioned below. Each entry consists of the concept itself (the actual idea or fact being classified), its entry number, class, learning level and a secondary reference (see diagram below).

Class	Concept	Level	Secondary Reference	Concept Number
Definition	/	Level 1	see also	A3 364
The BIOLOGICAL DIVERSITY (BIODIVERSITY) of life refers to the biosphere's genetic material, contained within the rich variety of life forms with which we share this planet.				

Index

Alternatively, you can find topics in the **index**, which lists concepts by their specific content (the index uses concept numbers, not page numbers, when referring to a topic). You may find relevant concepts listed under related topics as well.

Secondary reference

Each concept lists a section, subsection or category that contains information related to that concept. Using this **secondary reference** may help you find other concepts useful to your activity.

Step 2: Select Concepts

Once you have found concepts related to your topic, select those that are appropriate for your audience and teaching objective by using the following codings:

Learning level

Choose those concepts appropriate for grade level or skills level of audience using the **learning level** coding (see illustration above). Concepts are coded as level 1, 2 or 3. Generally, level 1 concepts should be taught before level 2, and level 2 taught before level 3.

Class

Use the **class** coding to help determine which concepts are most appropriate for your teaching objective. Concepts are classified as **definition**, **fact**, **opinion** and **issue** (some concepts have more than one classification).

Step 3: Order The Concepts

Having selected the concepts for your activity, use the codings to order the concepts to move students from awareness to participation in solving environmental problems.

By class and learning level

Using the codings above, order the concepts you choose from basic (**level 1**) to more complex (**level 3**) ideas, and to move students from awareness (of **issues**) to knowledge (of **facts**) to changes in attitudes (through **opinions**).

Using the Educator's Chart

When searching for concepts on a specific topic (**Forests**, for example), you most likely will want to read through every concept in that category. When looking for relevant concepts in *related* categories or subsections, however, you may want a shortcut. The **Educator's Chart** (pages 151-162) lets you search categories for specific concepts according to three classifications: learning level, class (both explained above), and **objective**.

This coding is based on the premise that environmental concepts contribute to the **awareness**, **knowledge**, **attitudes** and **participation** of the learner, as determined by the Tbilisi Conference goals for environmental education (see page 5). Each concept has been judged as contributing primarily to one or more of these concentric spheres of learning and behavior. (It should be understood that actual change in learner behavior is progressive and not usually the result of one or two concepts aimed specifically at increasing awareness or changing attitudes.)

SAMPLE SEARCH

The following section details the process of using the handbook for a specific search on the topic of biodiversity.

Teaching objective: Teach ninth grade general science students with background knowledge of ecosystem components and functions about the importance of biodiversity to humankind.

Step 1: Search For Relevant Concepts

Review table of contents

Turn to the table of contents to find **Biodiversity**. You'll see that it's listed as **category 3.3** under **subsection B3, Biotic Resources**. Turning to the page indicated (83), you'll see that **concepts 364-373** contain information about biodiversity. Read through the concepts to determine which contain information that might be useful for achieving your teaching objective. Of particular use to the teaching objective above are concepts 365, 366 and 367, all of which focus on the importance of biodiversity for resources and for stability of the biosphere.

You may also want to check related categories such as **Forests (B3.1)**, **Evolution & Extinction (A4.3)** or **Wildlife & Fisheries (B3.2)**; and related subsections such as **Biotic Components (A3)** or **Biological Systems (A5)**.

Search index

To find specific topics related to biodiversity, turn to the **index** (page 168). Under **Biodiversity**, there are references to concepts under the subheadings: **decline of, importance of, preservation of and resource potential of biodiversity**.

You may find relevant concepts listed under related topics. Under **Diversity**, for example, there are concepts listed under: **community, ecosystem, and species diversity**. Look for concepts related to biodiversity under headings like **Biosphere, Ecosystems, Forests, Genetic resources, Habitat, Rain forests, Resources, Species and Wildlife**.

Select Topic
and form
Teaching Objective

Find Topic In
Table Of Contents
• Sections
• Subsections
• Categories

Search Index for:
• Specific topic
• Related topics

Step 2: Select Concepts

Use the concept codings to determine which are most appropriate for your audience (ninth grade science students) and teaching objective (understanding the importance of biodiversity).

Learning level

Of the ten concepts in category B3.3 on Biodiversity, two are level 1, six are level 2, and two are level 3. You may want to use all the concepts, or only those of a certain level (depending on previous student knowledge about biodiversity).

Class

In category B3.3 there is one definition, five facts, two issues, one fact/issue and one opinion. Selection of concepts depends on your teaching objective: do you want to cover "just the facts" or to add the more subjective insights of issues and opinions?

Step 3: Order the Concepts

By class and learning level

In category B3.3, as in other categories, concepts are loosely arranged from simple to more complex ideas. Although the order in which concepts are taught is up to you, basic concepts such as the definition of biodiversity (364) should be understood before moving on to concepts such as its importance (365-7), its current global decline (368) and its preservation (371, 372).

Using the Educator's Chart

Biodiversity has many related topics, and you'll probably want to search several related categories for concepts relevant to your objective. As an example, category B3.2, Wildlife & Fisheries, has 24 entries, several of which deal with preservation of species and habitat. Since these concepts are, for the most part, levels 2 and 3, you could use the educator's chart to search for these level concepts in category B3.2. Alternatively, you could look for concepts to match your objective: since the objective is one of understanding rather than participation, choose concepts classified as fact or fact/issue. By combining these criteria, you can narrow the list down to a handful of the most relevant concepts.

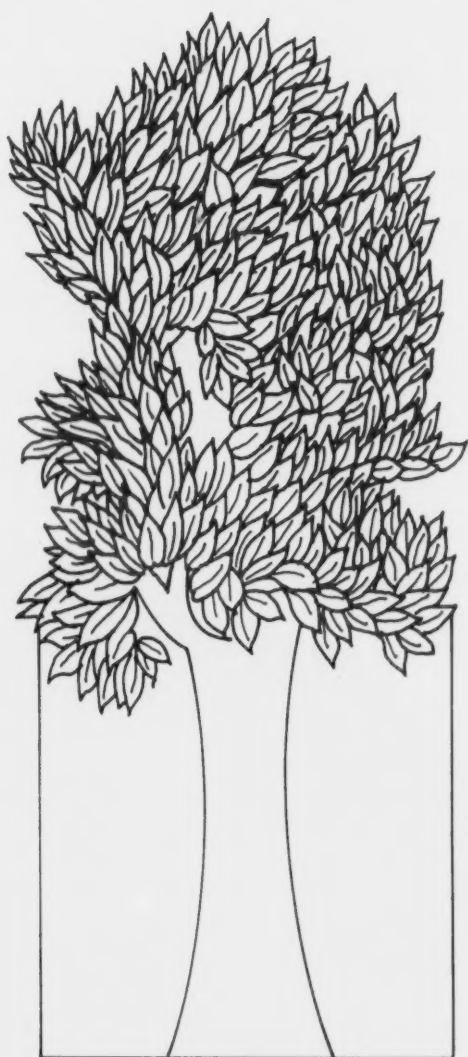
Select Concepts for Audience and Objectives

- Level of learning
- Class

Order Concepts to Move from Awareness to Participation

Use Educator's Chart to Sort Concepts by:

- Class
- Level
- Objective





A
NATURAL
SYSTEMS

A1
General

Environment A1.1

Fact	Level 1	<i>see also C1</i>	1
-------------	----------------	--------------------	----------

Your environment is your surroundings.

Definition	Level 1	<i>see also A2</i>	2
-------------------	----------------	--------------------	----------

ENVIRONMENT is the sum of all external conditions and influences affecting organisms. The environment may be divided into biotic (living) and abiotic (non-living) components.

Fact	Level 1	<i>see also A4</i>	3
-------------	----------------	--------------------	----------

Change is a fundamental characteristic of the environment. Some changes are rapid (such as an earthquake); others take thousands of years (movements of glaciers). Every change has consequences for the system as a whole and for its constituent organisms. Since most natural changes follow regular patterns, their sequences may be predictable.

Fact	Level 1	<i>see also B4</i>	4
-------------	----------------	--------------------	----------

In the environment, actions tend to have more than one effect. For example, the burning of fossil fuels changes the atmosphere, causes acid rain, and adversely affects our health.

Definition	Level 2	<i>see also C1</i>	5
-------------------	----------------	--------------------	----------

ENVIRONMENTAL SCIENCE is the study of environmental systems. It includes the study of physical and biological environments of organisms, and may also include the study of social and cultural factors as well as human impacts on the environment.

6 **Definition** **Level 1** *see also* **A5.0**

ECOLOGY is the study of the interrelationships among organisms and between organisms and their environment.

7 **Fact** **Level 1** *see also* **C1.1**

The word ecology is derived from the Greek word for house. In effect, ecology is the study of our home, the biosphere.

A1.2 Earth

8 **Fact** **Level 1** *see also*

The earth is a small planet in the universe. It is the only planet with life that we know of. The earth and its living things are closely interrelated and interdependent.

9 **Fact** **Level 1** *see also* **A4.3**

Dates from the oldest earth rocks suggest that the earth is about five billion years old. The earliest life appeared around four billion years ago, while the first humans appeared 2.5 million years ago.

10 **Fact** **Level 1** *see also* **A2**

The earth's position in the solar system promotes life. If our planet were closer to the sun, it would be too hot to support life as we know it. If it were farther away it would be too cold. In addition the earth's atmosphere and the presence of water are vital to life on earth.

11 **Fact** **Level 1** *see also* **A2**

The earth can be thought of as a 'spaceship' containing all the air, water and land we will ever have. The energy driving this 'spaceship' comes from the sun.

Fact	Level 2	<i>see also</i> A2.0	12
-------------	----------------	-----------------------------	-----------

We can think of the earth as being made up of four layers or spheres: the atmosphere (air), hydrosphere (water), lithosphere (land) and biosphere (life). The constant interactions of these in an ongoing process driven by the sun's energy and the internal heat of our planet form the features of the earth.

Biosphere	A1.3
------------------	-------------

Definition	Level 1	<i>see also</i> A3	13
-------------------	----------------	---------------------------	-----------

The BIOSPHERE is the part of the earth's surface where living organisms are found. It is a thin film of these organisms and the environment with which they interact.

Fact/Issue	Level 1	<i>see also</i> B1	14
-------------------	----------------	---------------------------	-----------

The biosphere is the only suitable habitat we have and its resources are finite.

Fact	Level 1	<i>see also</i> A2	15
-------------	----------------	---------------------------	-----------

The biosphere includes most of the hydrosphere and parts of the atmosphere and upper lithosphere.

Fact	Level 1	<i>see also</i>	16
-------------	----------------	-----------------	-----------

The biosphere can be studied by breaking it down into two parts: the living (biotic) components like plants and animals, and the non-living (abiotic) components like water and air.

A2

Abiotic
Components

A2.0

Definition	Level 1	<i>see also A3</i>	17
-------------------	----------------	--------------------	-----------

The physical or ABIOTIC environment includes all nonliving components of the biosphere which influence living organisms.

Fact	Level 1	<i>see also B2</i>	18
-------------	----------------	--------------------	-----------

Abiotic factors include soil, water, the atmosphere, and energy from various sources.

Fact	Level 2	<i>see also A4.3</i>	19
-------------	----------------	----------------------	-----------

All plants and animals are adapted to survive within the framework of their habitat's abiotic components. For example, a cactus' ability to retain water is an adaptation to dry desert climates.

Fact	Level 2	<i>see also A4.1</i>	20
-------------	----------------	----------------------	-----------

Abiotic components in combination usually determine the structure of an ecosystem. For example, the amount of rainfall, along with average temperature, may determine whether a region is characterized by forest, grassland or desert ecosystems.

Energy A2.1

Fact	Level 1	<i>see also B2.1</i>	21
-------------	----------------	----------------------	-----------

Our sun is a middle-aged star. It is expected to provide earth its energy for another four billion years.

-
- | | | | |
|-----------|-------------------|----------------|----------------------|
| 22 | Definition | Level 1 | <i>see also B2.1</i> |
|-----------|-------------------|----------------|----------------------|
-
- ENERGY is the capacity to perform work (for a living organism, work means all biological functions -- from breathing to hunting). Energy is essential for life to exist.
-
- | | | | |
|-----------|-------------|----------------|----------------------|
| 23 | Fact | Level 1 | <i>see also B2.1</i> |
|-----------|-------------|----------------|----------------------|
-
- There are different forms of energy, including thermal (heat), electromagnetic (light, magnetism), kinetic (motion), potential (gravity), nuclear and chemical.
-
- | | | | |
|-----------|-------------|----------------|----------------------|
| 24 | Fact | Level 2 | <i>see also A5.1</i> |
|-----------|-------------|----------------|----------------------|
-
- Energy cannot be created or destroyed, but can be changed from one form to another. For example, when food is consumed by an animal, chemical energy is converted to kinetic (movement) and thermal (heat) energy.
-
- | | | | |
|-----------|-------------|----------------|----------------------|
| 25 | Fact | Level 1 | <i>see also B2.1</i> |
|-----------|-------------|----------------|----------------------|
-
- The sun's energy comes from the fusion of hydrogen into helium under high temperature and pressure. This process releases huge amounts of nuclear energy.
-
- | | | | |
|-----------|-------------|----------------|----------------------|
| 26 | Fact | Level 2 | <i>see also A4.1</i> |
|-----------|-------------|----------------|----------------------|
-
- Solar energy powers the movement of global air masses, the hydrological cycle and ocean currents.
-
- | | | | |
|-----------|-------------|----------------|----------------------|
| 27 | Fact | Level 3 | <i>see also A4.1</i> |
|-----------|-------------|----------------|----------------------|
-
- The sun's effects on weather and climate are complex. The sun's energy drives weather processes and warms the earth. Seasonal changes occur as the earth shifts in relation to the sun. Weather fluctuations have also been linked to periods of sunspot activity.
-

Abiotic Components

A2.1

Fact	Level 1	<i>see also A5.1</i>	28
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The sun provides the vast majority of energy used by living organisms on earth.

Fact	Level 2	<i>see also A5.1</i>	29
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The process of life is based on the conversion, utilization, storage and transfer of energy. Plants convert solar energy to chemical energy used in growth and propagation. Animals that eat plants use part of this stored energy for their own growth and maintenance, while some is dissipated as heat.

Fact	Level 2	<i>see also A5.1</i>	30
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No energy conversion is 100 percent efficient. With each transfer of energy in a system, some energy is lost or "dissipates" from that system (mainly as heat energy). Dissipation results in an ENERGY DEFICIT.

Fact	Level 1	<i>see also A5.0</i>	31
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The ultimate source of energy in most ecosystems is sunlight.

Fact	Level 3	<i>see also A5.0</i>	32
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Energy drives the physiochemical (e.g., evaporation, availability of nutrients) and biological (e.g., metabolism) mechanisms of ecosystems. A constant influx of energy is required for organisms and ecosystems to sustain themselves.

Fact	Level 2	<i>see also A3.2</i>	33
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Organisms differ in how they use energy. Some animals use energy quickly for growth and metabolism, and therefore must replace it quickly (e.g., a hummingbird); others use energy more slowly and therefore need to replace it less frequently (e.g., a python).

A2.2 Atmosphere

34	Fact/Definition	Level 1	<i>see also</i>
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The earth's ATMOSPHERE is a mixture of gases occurring as layers of various thicknesses, densities and temperatures. Most of the atmosphere's mass lies below a height of about forty miles, but the outer atmosphere extends several thousand miles, thinning gradually as the effect of earth's gravity decreases.

35	Fact	Level 1	<i>see also A4.2</i>
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The atmosphere is composed of 78 percent nitrogen, 21 percent oxygen, 0.9 percent argon, and 0.03 percent carbon dioxide, plus small amounts of water vapor and dust, and trace amounts of other gases.

36	Fact	Level 2	<i>see also A4.2</i>
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The composition of our atmosphere has evolved over time through the exchange of gases as part of biotic (e.g., respiration) and abiotic (e.g., evaporation) processes. The atmosphere has co-evolved with life on earth.

37	Fact	Level 3	<i>see also A4.2</i>
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The primitive earth's atmosphere probably consisted of compound gases like methane, ammonia and water vapor. The atmosphere evolved through a series of events to its present form. Early marine life converted methane to carbon dioxide. Later, the processes of photosynthesis and respiration affected oxygen and carbon dioxide levels in the atmosphere.

38	Fact	Level 1	<i>see also A4.1</i>
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Atmospheric conditions such as temperature, wind, humidity, cloudiness, rain and movement of weather fronts are constantly changing.

Abiotic Components

A2.2

Fact	Level 2	<i>see also A4.1</i>	39
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Clouds reflect about half of the sun's radiation back into space. Some energy is retained as heat by the atmosphere. The rest is transmitted to the earth's surface, which reradiates energy as heat during the night. The ongoing process of evaporation and condensation also warms the atmosphere.

Fact/Issue	Level 3	<i>see also B4.2</i>	40
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The upper layer of the atmosphere contains ozone, a molecule of oxygen that screens out much of the sun's harmful ultraviolet radiation. Without ozone, life on earth probably could not have evolved to its present form. Certain chemicals released into the atmosphere are believed to be damaging the ozone layer.

Fact	Level 1	<i>see also A4.2</i>	41
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The atmosphere is one of our vital resources. It is the direct source of the carbon dioxide and oxygen required for life.

Issue	Level 3	<i>see also B4.2</i>	42
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The atmosphere's ability to disperse smoke and other particles has created the misconception that it has an unlimited capacity for absorbing pollution. Yet phenomena like the greenhouse effect and ozone depletion show that this capacity is limited.

Land & Soil A2.3

Fact	Level 2	<i>see also A4</i>	43
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The earth has undergone many changes throughout geologic history. Mountains have formed, seas have come and gone, continents have moved, many forms of life have evolved and met extinction, and there have been dramatic changes in climate. The land features present today are the results of these ongoing processes.

Fact

Level 3

see also C1.3

The rate and extent of physical changes to the landscape are governed by both natural and human influences. The texture and patterns of the earth have been fashioned over millions of years by glaciers, volcanoes, erosion and other natural processes. In more recent times the patterns of the earth have been increasingly altered by people.

Fact

Level 2

see also B2.3

Topography, geology and landforms to a large extent determine the distribution of plant and animal life, as well as the usage of land by humans.

Fact/Definition

Level 1

see also

The earth's crust is made up of a number of **TECTONIC PLATES** which are in constant though imperceptible motion. The **TECTONIC CYCLE** refers to the constant formation and destruction of the earth's crust at the edges of these plates. Where plates meet, landforms are created. For example, the Indian subcontinent is on a north-moving plate, which in its collision with the Eurasian plate has formed the Himalayas.

Fact

Level 2

see also

The shapes and positions of the continents are not permanent but evolve over time. They are the drifting fragments from the break-up of an ancient supercontinent, "Pangaea." This process may have occurred many times in earth's geologic history.

Fact

Level 2

see also

Earthquakes and volcanoes often occur near plate boundaries, where the forces of tectonic plates moving against one another create great heat and pressure.

Fact **Level 2** *see also B2.3* **49**

Precious metals like gold are distributed unevenly around the earth's surface because they are linked to areas of geologic activity, including the stress zones along edges of continental plates.

Definition/Fact **Level 2** *see also B2.3* **50**

EROSION is the physical or chemical removal of rocks or soil from the landscape by factors such as wind, water, ice (glaciers) and gravity (landslides). Although erosion is a natural process, humans can affect its rate. For example, plowing cropland increases erosion, while planting trees decreases it.

Fact/Definition **Level 1** *see also B2.3* **51**

SOIL is a mixture of organic and mineral material, and decomposer organisms (mainly bacteria and fungi). Soil is therefore both an abiotic and biotic component of the biosphere. It covers much of the earth's surface and forms a habitat for many organisms.

Fact/Definition **Level 2** *see also B2.3* **52**

Soil is the result of physical, chemical and biological processes such as weathering, erosion, decomposition of dead organisms, and root growth. These processes gradually lead to the development of soil layers or HORIZONS. The formation of soil is a slow process.

Fact **Level 2** *see also B2.3* **53**

Soil provides nutrients, water and support for plants, while air trapped in soil provides oxygen to plant roots. Organic material from plants affects soil texture and composition.

Fact **Level 1** *see also B2.3* **54**

There are many different types of soil as a result of differences in climate, vegetation, parent rock material, slope, groundwater, and age of the soil.

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| 55 | Definition/Fact | Level 2 | <i>see also A3.1</i> |
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- PLANT LITTER, the decaying remains of plants, acts as a buffer to prevent drastic changes in soil moisture, temperature and nutrient levels.
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A2.4 Water

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| 56 | Fact | Level 1 | <i>see also A5.4</i> |
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- All life requires water. Generally, habitats with abundant plant and animal life are in areas where water is in good supply.
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|-----------|-------------|----------------|----------------------|
| 57 | Fact | Level 1 | <i>see also B2.2</i> |
|-----------|-------------|----------------|----------------------|
- The physical properties of water (its capacity to absorb and store large amounts of heat, its high surface tension, and the fact that ice is less dense than water) are important for the existence of life as we know it.
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| 58 | Fact | Level 1 | <i>see also B2.2</i> |
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- Water is one of the most important requirements for life. However, more than 99 percent of the earth's water is not readily available because it is saline (seawater) or frozen (ice caps and glaciers). Thus all life, except marine life, depends on the remaining one percent.
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| 59 | Fact | Level 1 | <i>see also B2.2</i> |
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- The oceans cover about 71 percent of the earth's surface, and hold 97 percent of its water. Of the three percent of fresh water, about 75 percent is locked up in ice-caps and glaciers and much of the rest is groundwater. Only a fraction is present at any one time in lakes (0.3 percent) and rivers (0.03 percent).
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Fact	Level 1	<i>see also B2.2</i>	60
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Water makes up about two-thirds of the human body. We need about two quarts of water a day to remain healthy.

Fact/Definition	Level 2	<i>see also B2.2</i>	61
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Water is a universal SOLVENT -- that is, it has the ability to dissolve many materials. Hence it is useful as a cleaning agent and as a means for disposal of soluble wastes. However, water has a limited capacity for absorbing pollutants.

Fact	Level 2	<i>see also A3</i>	62
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Ice floats because the solid state of water is less dense than the liquid state. Ice and snow are good insulators. These factors enable aquatic life to continue underneath frozen layers of lakes and rivers in cold regions.

A3
Biotic
Components

Plant A3.1

Fact Level 1 *see also* A2 63

Green plants need sunlight, water and nutrients (minerals) to survive.

Definition Level 1 *see also* A5.1 64

Through the process of PHOTOSYNTHESIS, plants produce starch and other organic compounds which are the start of most food chains. Photosynthesis uses carbon dioxide and produces oxygen, which is required for respiration.

Fact Level 2 *see also* A4.3 65

Photosynthesis was a significant event in the evolution of the biosphere. Previously there was no free oxygen in the atmosphere. The release of oxygen through photosynthesis permitted the evolution of higher life forms as we know them.

Definition Level 1 *see also* A5.2 66

Different plant species growing together form PLANT COMMUNITIES, each member influencing its neighbors. When species occur together frequently in characteristic patterns these are called PLANT FORMATIONS or ASSOCIATIONS.

Fact Level 1 *see also* A2.3 67

The type and distribution of plants in any location is affected by climate, soil, and local and regional topography.

68 **Fact** **Level 2** *see also B3.1*

Plants form a protective canopy that reduces the impact of raindrops pounding against the soil, thereby reducing soil erosion. The layer of leaf litter prevents runoff and allows water to percolate into the ground. Roots form a matrix that holds soil in place, while dead parts of plants decompose to form humus, which holds water like a giant sponge.

69 **Fact** **Level 1** *see also C2*

Because of their nutritional qualities and ability to be cultivated on a large scale, we use plants as a major food source.

70 **Fact** **Level 1** *see also A4*

Plant productivity tends to be higher in the tropics than in temperate regions, due to dependable and abundant supplies of energy (sunlight) and moisture.

71 **Fact** **Level 2** *see also A2.0*

Insufficient sunlight in polar regions and deep ocean waters restricts plant growth. In polar regions and at high altitudes, growth is also limited by low temperatures and the fact that water is often frozen and unavailable to plants.

72 **Fact** **Level 1** *see also A5.4*

Plants provide habitats for numerous organisms. The hollows of a tree trunk, for example, are used by animals and birds, while its branches provide support for nests. Thousands of insects (ants, bees, beetles) and other organisms (lichens, mosses, microorganisms) may also live in or gather food from the tree.

73 **Fact** **Level 1** *see also B3.1*

Trees are an important component of the environment. Trees clean the air of dust particles, cool it on hot days and conserve heat at night, and are excellent sound absorbers.

Biotic Components

A3.1

Fact	Level 1	<i>see also B3.1</i>	74
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Forests are one of the largest and most complex types of ecosystems.

Fact	Level 2	<i>see also A2.3</i>	75
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Forests help prevent soil erosion and are important in soil formation. They enrich soils with their organic debris, and increase its porosity and water storage capacity.

Fact	Level 3	<i>see also B3.1</i>	76
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Forests control extremes of heat and cold, making the climate more equable. They produce large quantities of oxygen and remove excess carbon dioxide from the air. Transpiration from forests affects the relative humidity and sometimes local precipitation. Forests also reduce wind velocity.

Fact	Level 2	<i>see also B3.1</i>	77
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The diversity of forest communities is determined by climate, soil, geology and biotic activity.

Fact	Level 1	<i>see also B3.1</i>	78
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Forests are important to watersheds since they slow the flow of rainwater, thereby limiting floods, soil erosion and landslides.

Definition	Level 1	<i>see also A5.4</i>	79
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GRASSLANDS are characterized by plains with dense grasses, sparsely distributed trees and sometimes an abundance of herbs. The prairies of North America, steppes of Asia, and savannahs of Africa are climax grasslands. Grasslands provide ideal habitat for a rich variety of herbivores and their predators.

80 Definition/Fact Level 2 *see also* B3.2

PHYTOPLANKTON are tiny aquatic plants. They are the beginning of most marine food chains, and provide rich mineral deposits when they decompose on the sea floor. They supply nearly three-fourths of the total oxygen requirement of life on earth. In addition, they could be a possible future source of food for humans.

A3.2 Animal

81 Definition Level 1 *see also* B3.2

Animals include VERTEBRATES (with backbones -- fish, amphibians, reptiles, birds and mammals) and INVERTEBRATES (without backbones -- such as sponges, worms and insects).

82 Fact Level 3 *see also* B3.2

Every animal has a role in maintaining the balance of nature. For example, birds are important in controlling populations of insects, while insects themselves are vital for pollination of many plants.

83 Definition/Fact Level 2 *see also* A4.3

Some animals must adapt to extreme environmental conditions. These ADAPTATIONS may be behavioral (for example, hibernation of the polar bear during long arctic winters) or physical (such as the ability of desert animals and plants to exist on minimal amounts of water).

84 Fact Level 1 *see also* A4.3

Some animals are colored or can change color (like the chameleon) to blend visually with their background. This CAMOUFLAGE may serve as a means of protection from predators or a disguise during hunting.

Fact **Level 1** *see also B3.2* **85**

Animals communicate with each other to, among other things, signal the discovery of food, warn of danger, and attract the opposite sex. They communicate through sounds, movements, odors and color changes.

Fact **Level 1** *see also A5.4* **86**

Mobility in animals often helps them to escape unfavorable conditions. Many animals, including species of birds, insects, fish and mammals, MIGRATE long distances when seasons change to areas where conditions are more favorable for feeding and breeding.

Fact **Level 1** *see also B3.2* **87**

For every human being alive, there are about one million insects. Some reproduce more quickly and in greater numbers than almost any other kind of organism. Many insects are important in pollination and seed dispersal. Others feed on dead organisms and are therefore important in nutrient recycling.

Fact **Level 2** *see also C2.1* **88**

Insect pests destroy large amounts of crops each year. Others carry diseases affecting humans and animals. Efforts to control insects are hampered by their high reproductive rates and abilities to adapt to changing conditions. For example, many insect species quickly develop resistance to pesticides.

Fact **Level 1** *see also A4.2* **89**

Earthworms' burrowing helps aerate the soil and bring nutrients to the surface. In this process earthworms ingest and recycle organic wastes.

Fact **Level 1** *see also B3.2* **90**

Reptiles having venom use it to capture prey, defend themselves and aid in digestion. Not all snakes are venomous.

A4 Processes

Weather & Climate A4.1

Definition Level 1 see also A2.2 91

WEATHER is the condition of the atmosphere at any given time and place with respect to such factors as temperature, humidity, barometric pressure, precipitation and cloudiness.

Definition Level 1 see also A2.2 92

CLIMATE is the long-term regional condition of the atmosphere. It is determined by averaging the weather for a particular region or location over long periods of time.

Definition Level 1 see also A2.4 93

The HYDROLOGICAL CYCLE is the process by which water cycles between the atmosphere and the earth's surface. Water falls to the land as precipitation, is absorbed or runs off to rivers, streams and eventually the ocean. It then evaporates from the earth's surface, returning to the atmosphere as water vapor to form clouds and rain.

Fact Level 2 see also A4.2 94

The hydrosphere and atmosphere are interrelated through wind patterns, precipitation and chemical exchanges. For example, evaporation and precipitation cause changes in water densities that help drive ocean currents. Also, some of the carbon dioxide released by human activities like burning of fossil fuels is absorbed by the oceans.

Fact Level 2 see also A2.4 95

The oceans act as heat reservoirs and regulate the earth's climate. Land areas in winter are typically colder than oceans, whereas in summer, they tend to be warmer. Thus, in the interior of continents, temperature ranges over the year tend to be greater than near oceans.

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| 96 | Fact | Level 3 | <i>see also A2.2</i> |
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- Global air currents play a large role in weather and climate patterns. A shift in air currents can bring unusually warm, cold, dry or moist air to a region, causing floods, drought or other disturbances which may affect crop production and water supplies. An example is the hot, dry "Santa Ana winds" which occasionally bring periods of drought to parts of North America.
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| 97 | Definition | Level 2 | <i>see also A2.4</i> |
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- Ocean CURRENTS are patterns of water movement in the world's oceans. They are caused by a combination of forces, including gravity, horizontal pressure gradients caused by differences in water density, Coriolis forces caused by the rotation of the earth, and frictional forces due to winds. Ocean currents are important factors in global climate patterns.
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| 98 | Fact/Definition | Level 2 | <i>see also A2.3</i> |
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- Climate affects the GEOMORPHIC processes (erosion, sedimentation, soil formation, etc.) that give landscapes their characteristics.
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| 99 | Fact/Issue | Level 1 | <i>see also C1.2</i> |
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- Unexpected fluctuations in climatic patterns, such as extended droughts, can have drastic effects on life.
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| 100 | Fact | Level 3 | <i>see also C1.3</i> |
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- We have learned to understand and predict weather with some degree of accuracy. We are not able to control weather, however, and must still adapt to changes in climate. The effects humans are now having on global weather patterns are unintentional and potentially disastrous.
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Biogeochemical Cycles A4.2

Definition	Level 1	<i>see also A1.3</i>	101
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BIOGEOCHEMICAL CYCLES are the movement of elements between the biotic and abiotic components of the biosphere.

Fact	Level 1	<i>see also A3</i>	102
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Just six elements -- carbon, oxygen, nitrogen, hydrogen, phosphorous and sulfur -- make up 95 percent of the earth's biomass. Life depends on their efficient cycling through the biosphere.

Fact	Level 2	<i>see also B2.3</i>	103
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An example of a biogeochemical cycle is the cycling of carbon. It exists as carbon dioxide and as pure carbon in the abiotic state, and becomes part of an organic molecule when used by plants. It remains organic as it is passed along the food chain and as dead organisms decompose, then accumulates in the soil as organic matter. Some of it is then broken down again to the inorganic state. Carbon from dead organisms can be altered by heat and pressure to form coal, oil, graphite and diamonds.

Fact	Level 3	<i>see also A3.1</i>	104
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Some elements, such as oxygen and nitrogen, cycle quickly and so are readily available for use by organisms. Others, such as phosphorous, are released from their immobile forms slowly depending on soil acidity and other factors. These elements are often limiting factors in plant growth.

Definition/Fact	Level 1	<i>see also A3</i>	105
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NUTRIENTS are chemical elements or compounds essential for life. The most important of these are carbon, oxygen, hydrogen, nitrogen, potassium and phosphorous.

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| 106 | Fact | Level 2 | <i>see also A5.1</i> |
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- Nutrients are cycled and recycled through food chains from plants to herbivores to carnivores. Finally, decomposer organisms break down dead plants and animals and release their nutrients to the soil to be used again.
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| 107 | Fact | Level 2 | <i>see also A3</i> |
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- Biological processes such as photosynthesis and respiration are part of biogeochemical cycling.
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| 108 | Fact | Level 2 | <i>see also A3.1</i> |
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- Plants and animals are integral parts of many biogeochemical cycles. As an example, a hillside covered with grass will hold water and soil better than a bare slope, affecting the mineral and water cycles in the area.
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| 109 | Fact | Level 2 | <i>see also A2.3</i> |
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- Minerals removed from the land by erosion, and gases absorbed by the oceans from the atmosphere are both recycled by SEDIMENTATION on the ocean floor. Carbonate rocks such as limestone are formed by the deposition of calcium and magnesium carbonates by organisms like coral. Sandstone is formed near coastal areas where larger mineral particles are deposited. These rocks are solidified by pressure of burial, and millions of years later may rise above sea level to be worn away again.
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| 110 | Fact/Definition | Level 2 | <i>see also B4.2</i> |
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- EUTROPHICATION occurs when nutrients (minerals and organic matter) accumulate in aquatic ecosystems, increasing plant growth and depleting oxygen levels. Sediment from erosion along with domestic and industrial sewage speed eutrophication.
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Fact **Level 2** *see also* **A5.0** **111**

The oceans depend on the land for a constant influx of nutrients for the maintenance of life.

Issue/Fact **Level 3** *see also* **B4** **112**

We have adversely changed the balance of some biogeochemical cycles. For example, since 1860 combustion of fossil fuels has increased global carbon emissions more than fifty-fold. This has led to an almost 30 percent increase in atmospheric carbon dioxide levels.

Evolution & Extinction **A4.3**

Fact **Level 1** *see also* **A5.4** **113**

Each individual organism is the product of the combined influences of its heredity (genes) and its environment.

Fact **Level 1** *see also* **A5.4** **114**

Where an organism can live and how well it can reproduce are limited by its heredity and environment.

Fact/Definition **Level 1** *see also* **B3.3** **115**

New organisms arise from pre-existing organisms through EVOLUTION. Life has evolved over billions of years from microscopic single-celled organisms to the wide variety of extant organisms including the human species.

116 Fact **Level 2** *see also* **A5.3**

GENETIC VARIATION refers to the differences among individuals within a population. Variations arise through mutations (random changes in genetic material) and through new combinations of existing genes. Variation is believed to be one of the major factors in the evolutionary process.

117	Fact/Definition	Level 2	<i>see also</i> A5.3
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Variations are important because they hold the potential for new life forms. The environment acts as a screen for these variations: an individual with a variation favorable to its environment has a greater chance of surviving and reproducing. This process, known as **NATURAL SELECTION**, leads to the 'survival of the fittest'.

118	Definition/Fact	Level 1	<i>see also</i> A5.3
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A SPECIES is a distinct group of biological organisms capable of interbreeding yet isolated reproductively from all other organisms. SUBSPECIES or RACES sometimes occur when groups of the same species become isolated from one another and develop somewhat different forms. These groups can interbreed and produce fertile offspring if they are then reintroduced.

119 Fact Level 2 *see also* A5.3

When individuals of a population become geographically isolated for many generations from the parent population, new adaptive variations may arise, which may lead to the formation of new species.

120 **Fact** **Level 2** *see also* **A5.4**

Organisms living in a particular environment show similar adaptive characteristics. For example, many desert plants are fleshy, an adaptation which helps store water.

Fact/Definition Level 2 *see also* A5.4 121

Different species adapting to similar environments and establishing similar niches develop common traits. This process is known as **CONVERGENT EVOLUTION**. Examples of convergent evolution are the large flightless birds which evolved separately in Africa (the ostrich), South America (the rhea) and Australia (the emu).

Fact/Definition Level 2 *see also* A5.3 122

DIVERGENT EVOLUTION is the process by which a population is separated into isolated groups, each adapting to different environments and ultimately evolving into separate species. This usually occurs when part of the population migrates or is cut off by a physical boundary. For example, the Darwin finches of the Galapagos Islands, their ancestral population separated into isolated island groups, have evolved into many different species.

Definition Level 2 *see also* A5.4 123

CO-EVOLUTION is when two species evolve in response to each other's function and behavior. For example, birds that drink nectar developed long beaks in co-evolution with flowers that have long tubular bodies.

Definition Level 2 *see also* A5.4 124

A species introduced into a new geographic area is called an **EXOTIC** species. A species native to a particular area is called **ENDEMIC**. A species occurring over a large part of the world, wherever the environment is appropriate, is called a **COSMOPOLITAN** species.

Fact/Issue Level 3 *see also* A5.3 125

Introduced species are sometimes so successful that they displace native species and/or cause environmental problems. This happens because the introduced species often has no natural predators or other biological controls in its new habitat.

126 Fact/Definition Level 2 *see also* A5.3

EXTINCTION is the loss of a species, either from a specific habitat or completely from the earth. A species is said to be extinct when the last individual dies. Total extinction means the permanent loss of a species as a social, behavioral and genetic heritage.

127 Fact/Issue Level 3 *see also* A5.4

Inability of a species to adapt to its changing environment may result in its extinction. A large number of species have become extinct or are on the verge of extinction due to over-hunting or destruction of their habitat by humans.

128 Fact/Issue Level 3 *see also* C1.3

Extinctions can be caused by sudden fluctuations in one or more environmental factors, such as predation, disease, competition, climatic change or habitat alteration. Extinction is a natural process that has been accelerated by the activities of humans.

129 Fact/Issue Level 3 *see also* A5.1

It has been estimated that the extinction of one plant species can lead to the extinction of up to 30 other species, including interdependent insects, microorganisms, animals and other plants. Few of these relationships are known, making it difficult to predict the long-term effects of extinctions.

130 Fact/Issue Level 3 *see also* C4

All species are of ecological, aesthetic, educational, historical, recreational and scientific value. They represent vital links in a complex web of relationships. When a species becomes extinct, this link and its unique qualities are lost forever. Also lost are irreplaceable genetic resources.

131 Fact/Issue Level 3 *see also* A1.3

It is critical to monitor the rate of species extinction because this rate is a gauge of the health and stability of our biosphere.

A5
Biological
Systems

A5.0 Ecosystems

132 **Definition** **Level 1** *see also* **A1.3**

The biosphere may be examined at several levels. The highest is the **ECOSYSTEM**, a complex interacting system of living and nonliving components. The next level is **COMMUNITY**, a collection of interacting populations within a specific habitat. One ecosystem may contain many communities. A **POPULATION** consists of interbreeding individuals of one species living in the same habitat. A community contains populations of more than one species. Finally there is the **ORGANISM**, the individual itself. Ecosystems, communities and populations are all made up of individual organisms, interacting with each other and with the environment.

133 **Definition** **Level 1** *see also* **A1.3**

ECOSYSTEM is defined as a community of organisms and their physical environment acting as an ecological unit. Ecosystems consist of interacting abiotic (nonliving) components (solar energy, water, air, soil, etc.) and biotic (living) components (plants, animals, etc.). The abiotic components link with the biotic components through energy flows and nutrient cycling.

134 Fact Level 1 see also A1.3

Ecosystems can exist at many levels. They may be as small as a pond, or as large as a tropical rain forest.

135 **Definition** **Level 2** *see also* **A1.3**

BIOMES are major ecosystems of the biosphere. They are usually spread over large geographic areas with distinctive climates and characterized by a dominant vegetation (e.g., conifers, broad-leaved trees, or thorny shrubs) and animal life. Examples are the tropical rain forest, temperate deciduous forest, grassland and desert biomes.

Fact **Level 2** *see also A2.1* **136**

An ecosystem may be regarded as a machine fueled by energy and nutrients. Organisms decay, contributing nutrients to the soil which are then used by other organisms in the ecosystem. The energy used is almost always derived from the sun.

Fact **Level 2** *see also A2* **137**

The rate of release of nutrients and the flow of energy regulate the ecosystem.

Fact **Level 3** *see also A4.2* **138**

Ecosystems regulate themselves to a large extent. HOMEOSTASIS (the tendency to return to a state of equilibrium) leads to stability of ecosystems. This regulation is achieved through feedback mechanisms (physical, chemical, social or behavioral). For example, increases in atmospheric carbon dioxide are partially absorbed by the carbonate system of the seas.

Fact **Level 2** *see also A4.1* **139**

The stability of an ecosystem may be disrupted by non-human (fire, flood) or human (urbanization, pollution) factors. A large disturbance (volcanic eruption or prolonged drought) may alter or destroy an entire ecosystem.

Definition **Level 2** *see also A3* **140**

Ecosystems and their communities evolve over time, altered by, while at the same time altering, their local environment. This is called SUCCESSION. For example, a volcanic island can change from barren rock to lush rain forest as initial plant colonizers create conditions favorable to more complex species. Succession usually brings an increase in productivity, species diversity and stability of the ecosystem.

141 **Fact** **Level 2** *see also A3*

Mature or CLIMAX ecosystems are the final stages of succession. They are believed to be more stable, and often have a greater diversity of plants and animals, than pre-climax ecosystems.

142 **Fact** **Level 3** *see also C2*

Natural ecosystems (forests, deserts) are self-sustaining in that they function within the limits of available resources. Sustaining artificial ecosystems (cities, agricultural fields) requires external resources. For example, both cities and agricultural fields often require subsidies of water, nutrients and energy.

[illegible]

Each ecosystem has several fundamental characteristics that derive from the interactions of its components. In order to understand these characteristics the ecosystem must be understood in its entirety.

A5.1 Food Chains & Webs

144 **Definition/Fact** **Level 2** *see also* **A3**

The biotic components of ecosystems are **AUTOTROPHS** (mostly green plants), which make their own food, and **HETEROTROPHS** (animals), which obtain their food directly or indirectly from plants. These are linked by food webs and food chains.

145	Definition	Level 1	<i>see also</i> A3.1
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PHOTOSYNTHESIS is the process by which green plants use solar energy to convert water, carbon dioxide, and small amounts of minerals into high-energy organic compounds (starch or carbohydrates).

Fact **Level 2** *see also A3.1* **146**

Plants and some bacteria are the only organisms which can directly capture sunlight to produce food by photosynthesis. Without this vital process, there would be little life on earth. The only exceptions are certain species that live in the deep sea drawing their energy and nutrients from geothermal vents.

Definition **Level 1** *see also A2.1* **147**

The sequence of organisms through which energy is transferred in an ecosystem is called a FOOD CHAIN.

Fact **Level 1** *see also A3* **148**

All organisms are part of a food chain, and may be part of more than one.

Fact/Definition **Level 1** *see also A3* **149**

Food chains consist of PRODUCERS (mainly green plants) which make their own food, and CONSUMERS. Consumers can be HERBIVORES (plant eaters), CARNIVORES (animal eaters), OMNIVORES (both plant and animal eaters), or DECOMPOSERS (dead organism eaters).

Definition **Level 1** *see also A4.2* **150**

DECOMPOSERS (primarily bacteria, fungi, nematodes, mites and certain insects) are organisms that feed by degrading organic matter. They are essential components of all nutrient cycles and food chains.

Fact **Level 2** *see also B4* **151**

Decomposers break down organic wastes and recycle their nutrients, but there are limits to their effectiveness. For example, untreated sewage and food wastes dumped into a body of water can cause rapid growth in the population of aerobic (oxygen-using) decomposers, which quickly deplete their supply of oxygen so that they cannot continue to function.

152 **Fact** **Level 2** *see also A5.2*

Producers, consumers and decomposers live interdependently in a community.

[illegible]

There are two major types of food chains. The first starts from a base of green plants and goes on to herbivores and carnivores. The other starts from a base of dead organic matter, proceeding to a variety of other organisms including scavengers, insects and microorganisms. The two chains are linked, as dead organisms from the first form the base of the second, which in turn provides nutrients vital to the first.

154	Definition	Level 1	<i>see also</i> A5.3
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A TROPHIC LEVEL consists of those organisms in a food chain that are the same number of steps away from the original source of energy. Green plants are grouped in the first trophic level (producers); herbivores in the second level (primary consumers); carnivores that feed on herbivores in the third (secondary consumers); and so on.

155 **Definition** **Level 2** *see also* **A5.3**

Trophic levels may be organized into ECOLOGICAL PYRAMIDS, with producers at the base and successive levels of consumers forming the higher layers. Pyramids can be based on numbers of organisms or amount of biomass at each level, energy flow, or other dynamics.

156 Fact Level 1 *see also* A3

Food chains are seldom isolated; usually they are part of an interlocking pattern called a **FOOD WEB**.

[illegible]

Every community has a unique food web and ecological pyramid.

Fact **Level 2** *see also* **A2.1** **158**

At each link in a food chain, 80 to 90 percent of the energy transferred is dissipated as heat. Because of this loss, there are fewer individuals at each successive level in the food chain. This usually limits the links in the food chain to four or five.

Definition/Fact **Level 2** *see also* **B4.2** **159**

BIOMAGNIFICATION is the process by which certain chemicals in the environment become concentrated as they move from one organism to another in the food chain. Mercury dumped into rivers, for example, can enter the aquatic food chain, building up to higher levels in larger organisms. Ultimately, humans who consume mercury-contaminated fish may develop mercury poisoning.

Definition **Level 2** *see also* **A5.2** **160**

BIOMASS is an estimate of the total mass of organisms that make up all or part of a population, community or other specified unit. There are various ways of measuring or estimating biomass.

Definition **Level 2** *see also* **A5.3** **161**

PRODUCTION refers to the actual rate of accumulation of biomass, organic matter or energy by a population or trophic unit.

Fact **Level 3** *see also* **A5.3** **162**

In natural ecosystems, abiotic factors such as soil quality, water, air and sunlight, and biotic factors such as competition and rate of reproduction influence the production of biomass.

Definition **Level 3** *see also* **A3.1** **163**

GROSS PRODUCTION is the increase in biomass before any is consumed or eliminated (e.g., in a plant it includes all sugars produced by the plant before any are used -- even by the leaves). NET PRODUCTION is gross production minus the energy used by the plant in respiration and other processes (in other words, all biomass that goes toward growth and reproduction).

164 Definition Level 2 *see also* A3

PRIMARY PRODUCTION is the addition of new biomass by plants.
SECONDARY PRODUCTION is the biomass produced by animals as they consume these plants.

165 Fact/Definition Level 3 *see also* A2.0

The rate of production of biomass in an ecosystem is called PRODUCTIVITY. Productivity is determined by availability of nutrients, water and solar energy. Oceans and deserts (hot and cold) are among the least productive ecosystems because they are limited in one or more of these three essentials. Estuaries, coral reefs and tropical forests are among the most productive ecosystems.

166 Fact Level 3 *see also* A4.1

Of all the major climatic regions, the equatorial regions receive the least variable levels of heat, moisture and light. High biomass production and productivity are characteristic of these regions.

A5.2 Community

167 Definition Level 2 *see also* A5.0

A BIOTIC COMMUNITY is a group of populations living in a defined area or habitat, functioning as a unit with certain definable characteristics. It is the sum of the living components of an ecosystem.

168 Fact Level 1 *see also* A5.0

A community can range in size and complexity from the organisms in a stagnant puddle to those in an entire ocean.

Definition **Level 2** *see also* **A2.1** **169**

MAJOR COMMUNITIES are sufficiently large and well-organized to be mostly independent of surrounding communities, drawing only upon the energy of the sun to drive their metabolic functions. MINOR COMMUNITIES, on the other hand, depend to a large extent on interactions with neighboring communities.

Fact **Level 3** *see also* **A5.0** **170**

Communities have clearly-defined unities of form (trophic structure) and function (energy flow patterns). They also have "compositional unity"; that is, certain species usually occur together. Individual species, however, are largely replaceable within any given community structure.

Fact **Level 3** *see also* **A5.4** **171**

Communities may be classified according to major structural features (such as dominant species), physical habitat (e.g., marine), or functional attributes (such as the type of community metabolism).

Fact **Level 2** *see also* **A5.0** **172**

Communities are often defined by physical or biological boundaries determined by the observer. Although these boundaries may be sharp, more often they are gradual, with one community blending into another.

Definition/Fact **Level 3** *see also* **A5.4** **173**

An ECOTONE is a transitional area between two or more communities (e.g., between desert and grassland). Often, this region is characterized by greater species diversity and population density than the bordering communities. This tendency is known as the EDGE EFFECT.

Each community usually has a small number of species with many individuals (abundant) and a large number of species with few individuals (rare). The SPECIES DIVERSITY of a community is usually determined by the number of rare species found, while the overall STRUCTURE or PATTERN of the community is largely determined by the abundant species.

An ecosystem consists of one or more communities interacting with the environment of the defined area.

Communities, like ecosystems, change over time in the process of succession. **PRIMARY SUCCESSION** is the initial establishment of a community in a previously uninhabited area (for example, plants colonizing a lava flow). **SECONDARY SUCCESSION** follows destruction of all or part of an earlier community (such as woodlands redeveloping on abandoned pasture).

The final successional community which is relatively stable and in equilibrium with its environment is called the **CLIMAX COMMUNITY**. It will usually contain one dominant or several co-dominant species.

Even stable communities are susceptible to natural or human disturbances and environmental change. Some stable communities (e.g., tropical rain forests, coral reefs) are among the most threatened by human activities.

Population A5.3

Definition	Level 1	<i>see also</i> A4.3	179
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A POPULATION is a group of naturally-interbreeding individuals of one species of plant or animal, living in a defined area and usually isolated to some degree from similar groups.

Fact	Level 2	<i>see also</i> A5.1	180
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Populations are dynamic: they increase, decrease or stabilize depending on their interactions with other populations and with their environment.

Fact	Level 1	<i>see also</i> A5.2	181
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Useful indicators for the study of populations are birth rates, death rates, growth rates, densities, immigration rates, emigration rates and age structures.

Fact	Level 2	<i>see also</i> B4.1	182
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All populations have potential for exponential growth, but this is usually limited by available resources (space, food), physical factors (rainfall, temperature) and biological controls (competition, predation).

Definition	Level 1	<i>see also</i> A4.2	183
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A LIMITING FACTOR is any factor of the environment which in excess (e.g., salinity in soils) or insufficient amounts (e.g., water in deserts) diminishes a population or inhibits the growth or reproduction of an individual organism.

184 Definition Level 1 *see also* B1.3

The CARRYING CAPACITY of an ecosystem is the maximum population of a given organism that the system can hold without being degraded. There is a carrying capacity for the biosphere, for each ecosystem and for each habitat. Carrying capacity is influenced by many variables, and can be altered by the management or mismanagement of resources.

185 Fact Level 2 *see also* B4.1

The carrying capacity of a system varies with environmental conditions. For example, drought will lower the carrying capacity of an ecosystem.

186 Fact Level 2 *see also* A5.4

When a population increases beyond the carrying capacity of its habitat, the environment deteriorates and the population may decline sharply until a new equilibrium is reached.

187 Fact Level 2 *see also* C1.3

ENVIRONMENTAL BARRIERS, whether natural (e.g., mountains) or artificial (roads, cities), influence the distribution and spread of populations.

188 Fact/Definition Level 2 *see also* A5.4

When a population is introduced into a favorable habitat, its birth rate (NATALITY) is often greater than its death rate (MORTALITY), and the population grows. Growth levels off as birth and death rates equalize; decline occurs when death rate exceeds birth rate.

Fact **Level 3** *see also A5.2* **189**

There are two basic life cycle strategies at the population level. One type of population has a high reproduction and dispersal rate. These tend to be smaller, less specialized species with shorter life spans (annual plants, beetles, mice). They characterize the early stages of succession. The second type of population is typical of later stages of succession. These species have slower reproduction and dispersal, are larger and longer-lived (trees, elephants, birds of prey), and are specialized for stable habitats.

Fact **Level 1** *see also A5.1* **190**

Interactions among and between populations include territoriality, symbiosis, parasitism, predation and competition.

Definition **Level 2** *see also A5.4* **191**

Territorial behavior or TERRITORIALITY is when an animal, whether fish, reptile, bird, mammal or insect, defends part of its habitat against other individuals or groups. It is usually associated with feeding and mating behaviors.

Definition **Level 1** *see also A5.1* **192**

SYMBIOSIS refers to a relationship between two species that interact for their mutual benefit, or for the benefit of one but with no harm to the other. For instance, the cattle egret feeding on the insects on the back of a water buffalo gets food while the buffalo is relieved of its pests.

Definition **Level 1** *see also A5.1* **193**

PARASITISM is a form of symbiosis that occurs when individuals of one species (the PARASITE) live in or on individuals of another species (the HOST), obtaining from them part or all of their nourishment. The host species is usually weakened by the interaction but is rarely killed.

194 **Definition** **Level 2** *see also* **A5.1**

PREDATION is the consumption of one animal (PREY) by another (PREDATOR). Predation is important to the stability of the ecosystem, as it helps keep prey populations within the habitat's carrying capacity.

195 **Fact** **Level 2** *see also* **A5.1**

An intricate relationship exists between predator and prey. The predator benefits directly from the prey's flesh; the prey population benefits by having weaker individuals removed from its population.

196 **Definition** **Level 1** *see also* **A5.4**

COMPETITION results when two or more individuals or populations in a habitat struggle for the same resource. A classic example is the competition for light in the early stages of seedling development.

A5.4 Habitat & Niche

197 **Definition** **Level 1** *see also* **A5.2**

HABITAT is the locality or particular type of environment naturally occupied by a species. For example, the grassy plains of the Serengeti are the African Lion's habitat.

198 **Fact** **Level 2** *see also* **A4.3**

Organisms are adapted to the particular abiotic and biotic conditions of their habitats. For example, the long fur of wolves makes them well-suited to the cold winters of northern regions, while their endurance allows them to capture the fleet-footed prey of these regions.

Definition **Level 2** *see also* **A5.2** **199**

A NICHE is the ecological role of a species in a community and the sum of its requirements for existence. It can be thought of as the "space" to which an organism is restricted by its needs and by the influence of other species (competitors, predators, etc.).

Fact **Level 2** *see also* **A4.3** **200**

Species which occupy well-defined niches often exhibit highly specialized features. For example, the polar bear, a large carnivore occupying cold, snow-covered regions, has developed a white coat which camouflages it from its prey while providing insulation in icy waters and frigid arctic air.

Fact **Level 3** *see also* **B3** **201**

Each species has a particular habitat and niche resulting from its unique adaptation to its environment. Understanding habitat and niche requirements helps us manage species.

Fact **Level 2** *see also* **A5.1** **202**

Similar ecological niches may be occupied by different species in separate communities. For example, the lion of the African grasslands occupies a similar niche as the tiger in Indian forests. They are both large carnivores occupying the top of their food chains.

Fact **Level 2** *see also* **A5.2** **203**

It is a basic tenet of ecology that no two species may occupy the same niche in a community for extended periods of time.

Fact **Level 3** *see also* **B3.3** **204**

Diversity within a habitat leads to niche diversity. For example, a habitat with both wet and dry zones will have more types of plants and animals occupying a greater variety of niches than a habitat that is just wet or just dry.

205

Fact

Level 3

see also A4.3

Extinction of a single species could leave an unoccupied niche. That niche could be occupied by another species -- for example, by a former competitor to the extinct species. If the niche cannot be filled, however, the entire ecosystem might collapse.

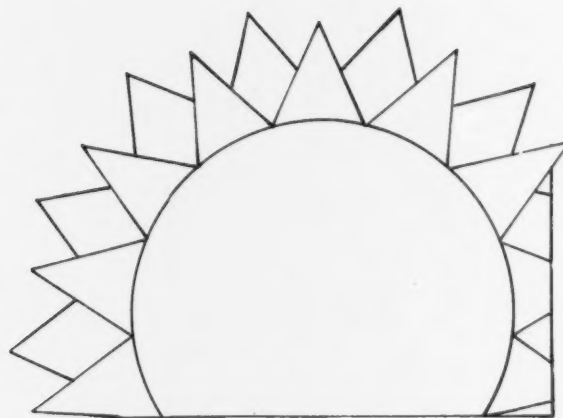
206

Fact/Issue

Level 3

see also A4

Both plant and animal populations increase or decrease in response to the expansion or reduction of habitat. Humans are largely responsible for changing habitats (e.g., converting forests to crop lands). As a result some species have become extinct while others which thrive in human-altered environments have become abundant. Overall, the number of species (species diversity) has declined.



B RESOURCES

B1
Natural
Resources

General B1.1

Fact Level 1 *see also* C1.2 207

People all over the world have similar BASIC NEEDS like food, shelter, clothing, recreation and social interactions.

Fact Level 1 *see also* C3 208

People meet their needs through their own labor and the collective labor of others.

Issue Level 1 *see also* C2 209

Humans need food, air and water to survive. However, because we have become dependent upon technology, we have created a variety of other needs and wants including rapid transportation, dependable power supplies, and control of our physical environment.

Fact Level 1 *see also* C1.2 210

The basic origin of all our material goods is natural resources.

Definition Level 1 *see also* C2 211

NATURAL RESOURCES are raw materials and energy obtained or derived from the environment.

Fact Level 2 *see also* B4.1 212

Natural resources renew themselves over various lengths of time. For example, it takes millions of years for minerals to form, hundreds of years for soil to develop, and tens of years for a tree to mature.

213 Fact Level 1 *see also* B1.3

Natural resources may be classified as renewable (e.g., water, plants, animals) or non-renewable (e.g., minerals). Air and water may be considered "flow resources" of which it is difficult to establish ownership.

214 Definition/Fact Level 2 *see also* B4.1

RENEWABLE RESOURCES are those replenished through relatively rapid natural cycles. However, even these resources are finite when demands for them outpace the period for natural regrowth. For example, the large-scale felling of trees does not allow the complete regrowth of forests.

215 **Definition** **Level 2** *see also* B1.3

NONRENEWABLE RESOURCES are those replenished through extremely slow natural cycles (fossil fuels) or which for all practical human purposes are not recycled at all (mineral deposits).

B1.2 Distribution & Consumption

216 Fact Level 1 *see also* C4

The availability of resources depends on current levels of technology and on human priorities (i.e., economic versus environmental concerns).

217	Fact/Issue	Level 1	<i>see also</i> C3.2
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The resources of the earth are neither distributed evenly (or "fairly"), nor are they exploited equally (or "fairly").

Fact/Issue **Level 1** *see also C3.1* **218**

What determines a resource's economic value is its supply and demand in the context of the values, needs and wants of a society. The value of a natural resource increases as availability of that resource decreases, or as demand for the resource increases.

Fact **Level 3** *see also B1.3* **219**

Exploitation of the most accessible resources increases the cost of developing the remaining supplies. For example, the cost of extracting metal from poor ores is greater than extracting from rich ores. Yet when the richest deposits are exhausted, only the poor quality or hard to reach ore remains.

Fact/Issue **Level 1** *see also B1.3* **220**

As resources decrease and demands increase, competition for these resources also increases. In turn, prices rise and fewer people have access to them.

Issue **Level 2** *see also C3.2* **221**

Scarcity of natural resources has been a basic cause for conflicts between people both as individuals and as nations.

Opinion **Level 2** *see also C4* **222**

Scarcity of resources requires sharing of resources. How they are shared depends on social and cultural values, economics and the political system.

Issue **Level 2** *see also C1.4* **223**

People of the world consume disproportionate amounts of the earth's resources. This is a factor of both population size and unequitable geographic or economic distribution of resources. The U.S., with 250 million people, has a much higher per capita consumption of resources than India, with 800 million people.

224 Issue Level 2 see also C1.4

Overall, per capita consumption is increasing. It has been estimated that the world is capable of supporting only one billion people, or just one-fifth the current global population, at the standards of wealth currently enjoyed by the most developed nations.

225 Issue Level 3 see also C1.4

Choices between needs (essentials) and wants (non-essentials) may come into conflict more frequently as humankind's population and consumption levels rise within finite resource limits.

226 Issue/Opinion **Level 3** *see also* C3.1

Developing countries sometimes export their resources for the benefit of richer countries, using their labor resources to extract and export these materials at poor terms of trade. The developed countries, with 20 percent of the world's population, consume 80 percent of the world's resources.

227 Fact/Issue Level 2 *see also* B4

Natural resources may undergo many processes (e.g., quarrying limestone, refining oil) between extraction and use. These steps often impact the environment in negative ways.

B1.3 Management & Conservation

228 **Fact/Issue** **Level 1** *see also* C1.4

Growing population, increasing individual consumption and poor management are leading to a decline in natural resources.

Natural Resources

B1.3

Opinion	Level 2	<i>see also B1.4</i>	229
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Studying and understanding resources is vital to managing and protecting them for future use.

Fact	Level 1	<i>see also B1.2</i>	230
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Effective ways to conserve both renewable and nonrenewable resources include reducing wasteful consumption and recycling materials whenever possible.

Issue	Level 1	<i>see also B1.2</i>	231
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One resource can sometimes be substituted for another. But substitution of resources does not necessarily result in conservation. True conservation of resources requires a decrease in their use.

Opinion	Level 1	<i>see also B1.4</i>	232
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We should not exhaust our resource capital, but try to live on the interest -- the renewable resources.

Fact	Level 2	<i>see also B1.4</i>	233
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Environmental management tactics should vary with the environment and the resources to be managed.

Opinion/Issue	Level 2	<i>see also C3</i>	234
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Sound resource management depends on clear definitions of goals in both social and ecological terms. For example, wildlife conservation should consider human needs as well as the needs of wildlife.

Opinion	Level 1	<i>see also C4.2</i>	235
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Information is necessary to protect or manage any system -- a biosphere reserve or a metropolitan area. The data must be current, relevant and accurate.

236 **Opinion** **Level 2** *see also C4.4*

Effective conservation programs should involve the communities adjacent to the resource or affected by resource-use policy changes.

237 **Definition/Issue** **Level 2** *see also B1.4*

MULTIPLE-USE MANAGEMENT means management of a resource for the greatest possible good, for the longest time, with the least possible environmental damage. It means meeting many rather than single needs. (For example, multiple-use management of wetlands may meet needs for water storage, food production, flood control, wildlife habitat and recreation.)

238 **Definition** **Level 1** *see also B1.4*

SUSTAINED YIELD means managing forestry, agricultural or other resources so that they produce continuously, unimpaired by periodic harvests.

239 **Opinion/Issue** **Level 2** *see also A1.3*

The biosphere has a carrying capacity based on its limited resource base. But because this carrying capacity is unknown, we must use resources conservatively.

240 **Opinion** **Level 2** *see also B1.2*

The biosphere is capable of providing an acceptable quality of life for all people if resources are wisely conserved and fairly distributed.

241 **Opinion/Issue** **Level 3** *see also B1.2*

Wise management of resources requires that we view them from a global perspective.

Issue	Level 3	<i>see also</i> B1.4	242
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The lives of future generations depend on our use of resources today.

Sustainable Development **B1.4**

Definition	Level 3	<i>see also</i> C3	243
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SUSTAINABLE DEVELOPMENT is a process of change in which the exploitation of resources, direction of investment, orientation of technical development, and institutional change are made consistent with future as well as present social and economic needs.

Issue	Level 3	<i>see also</i> C3	244
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Sustainable development does not imply absolute limits on economic growth, but takes into account the limitations imposed by the present state of technology, societal values, availability of resources, and the ability of the biosphere to absorb the effects of human activities.

Opinion	Level 2	<i>see also</i> C4.1	245
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When environment and development concerns are merged, a better set of goals evolve. These include a better quality of life, satisfaction of basic human needs, sustainability of development, respect for the biosphere, and concern for the needs of future generations.

Opinion	Level 2	<i>see also</i> B2.4	246
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We should strive to develop those energy sources which are ecologically most acceptable (i.e., least damaging and most sustainable). Even though they may be less economical in the short-term, long-term benefits should also be considered.

247 **Fact/Issue** **Level 2** *see also* **B2.4**

In many developing nations, over 90 percent of domestic energy is supplied by wood. By the year 2000, some 2.4 billion rural people will be using fuelwood faster than it is being replenished. Creating fuelwood plantations on marginal land is one approach to meeting fuelwood demands.

248 **Fact** **Level 1** *see also* **B2.1**

For thousands of years people have been using the sun to dry grain, fruit and timber. But traditional open-air methods are slow, and the food sometimes decays before it dries. Simple solar dryers speed up the drying process and protect the food from pests, dust and rain.

B2
Abiotic
Resources

249 Fact Level 1 *see also* B1.2

250	Fact/Issue	Level 1	<i>see also</i> B1.2
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251 **Fact/Definition** **Level 1** *see also* B1.2

252 Fact Level 2 *see also* B1.2

253 **Fact/Issue** **Level 2** *see also* B1.2

254 Fact Level 2 *see also* B1.3

74

Fact **Level 1** *see also* **B1.3** **255**

Fossil fuel will be exhausted as an energy source in several hundred years. Globally, the demand for oil is expected to exceed production before A.D. 2000.

Issue **Level 3** *see also* **B4.2** **256**

The environmental disruption caused by the development of fossil fuels must be weighed against the benefits of their energy. Exploration and production of oil and natural gas can have a number of environmental impacts, particularly in the event of accidents (e.g., tanker spills).

Fact **Level 3** *see also* **B1.3** **257**

Good conservation practices combined with pollution control and land reclamation can help minimize the environmental disruption caused by using fossil fuels.

Fact/Definition **Level 1** *see also* **B1.2** **258**

RENEWABLE ENERGY SOURCES are those which can be replenished relatively rapidly. They take a variety of forms, including wind power, hydropower, solar energy, and energy from biological processes (such as trees used for fuelwood). Even these, however, can be exhausted when their rate of use exceeds their rate of replenishment.

Fact/Issue **Level 2** *see also* **B4.1** **259**

Renewable energy sources may cause less environmental disruption than non-renewable energy sources (for example, solar collectors, which do not cause pollution). However, renewable energy sources can also damage the environment (e.g., large hydropower projects).

260 Fact Level 1 see also B1.2

Water is the source of one-fourth of the world's electricity. HYDROPOWER (water motion converted to usable energy) resources, unlike fossil fuels, are widely dispersed through the world. Asia has more than one-fourth of the world's potential hydropower resources; South America one-fifth and North and Central America about one-sixth.

261	Fact/Issue	Level 3	<i>see also</i> B4
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If all the economically available hydropower potential were harnessed, most of the world's electricity needs could be satisfied. However, this would come at enormous environmental costs.

262 Issue Level 2 *see also* B4

Like other forms of energy, hydropower has drawbacks. Hydropower projects invariably change watersheds, and sometimes whole ecosystems. Their reservoirs can submerge hundreds or thousands of acres of forest and agricultural land, and may cause the displacement of thousands of people.

263 Fact Level 1 see also B1.4

SOLAR ENERGY is a viable energy source for cooking, heating, and when large collectors are used, generation of electricity. Drawbacks of solar energy are that it requires large collectors to generate useful amounts of electricity, and the energy obtained requires storage (for use at night and on cloudy days).

264 Fact Level 3 *see also* B1.4

There are many reasons for further development of solar energy to meet human needs. The source is inexhaustible, it does not have to be transported and its use does not cause pollution.

265 Fact Level 2 see also B1.4

Solar energy can be harvested indirectly through water energy, wind energy and the stored energy from plants grown as fuel.

Fact/Issue	Level 3	<i>see also B1.4</i>	266
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Solar energy collectors do not pollute, explode, or cause cancer. They produce no bomb grade materials or radioactive waste.

Definition/Fact	Level 1	<i>see also B1.4</i>	267
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WIND ENERGY refers to the use of wind power for creating electricity or moving objects (water pumps, grinding stones). Wind has commercial potential for the generation of electricity when many windmills are used. Even one windmill can supply energy for local use, such as lifting water for irrigation.

Definition/Fact	Level 2	<i>see also B1.4</i>	268
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GEOTHERMAL ENERGY is heat from the earth used to generate electricity or heat buildings. It is an effective and cheap energy source, but is largely limited to places where geothermal springs occur naturally. There are some problems when these waters are used because they may contain trace minerals, such as arsenic, which can pollute drinking water supplies.

Fact	Level 2	<i>see also B3.1</i>	269
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FUELWOOD contributes about ten percent of the total energy consumed in the world. Fuelwood and charcoal are basic needs of many rural households, and also meet the energy requirements of a number of industries.

Fact	Level 1	<i>see also B1.4</i>	270
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Wastes (crop residues, animal dung) are increasingly used to generate energy in some parts of the world. Animal wastes can be used to generate biogas, while solid wastes are burned to generate electricity.

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| 271 | Fact/Issue | Level 2 | <i>see also B4</i> |
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- NUCLEAR POWER uses the energy released from splitting uranium atoms to generate electricity. It requires expensive technology and is controversial because it generates radioactive waste. Also, as in the recent accident at Chernobyl, USSR, nuclear power accidents can release radioactivity into the biosphere. When this radioactivity then crosses national boundaries, nuclear power can become very controversial indeed!
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| 272 | Issue/Opinion | Level 3 | <i>see also B1.4</i> |
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- No single energy source can meet all our needs while maintaining the quality of our environment. We must therefore explore all energy options, including nuclear power and renewable sources, and develop a comprehensive plan for present and future energy needs.
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| 273 | Fact/Issue | Level 2 | <i>see also B1.3</i> |
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- We frequently, knowingly and unknowingly, waste energy (inefficient automobile engines, letting food go to waste, etc.).
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| 274 | Fact | Level 2 | <i>see also B1.2</i> |
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- Mineral resources are continually being formed by geologic processes, but the rate is so slow that we can rely only on those deposits already in existence. The current rate of mineral use far exceeds the rate of formation. Mineral resources are thus considered nonrenewable.
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| 275 | Opinion | Level 2 | <i>see also C2</i> |
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- Without minerals from the earth and petroleum and other organic resources, modern products such as synthetic fibers, drugs and silicon chips would not be possible. It is unlikely we would have advanced into the industrial age or present technological era without extensive use of these resources.
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Fact	Level 1	<i>see also B4</i>	276
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The extraction of minerals can have negative effects on the environment.

Fact/Issue	Level 2	<i>see also B4</i>	277
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Shaft (underground) mining can damage the environment and jeopardize human health. Waste material brought to the surface can cover large areas, while timber for tunnel supports requires the felling of many trees. Water that drains from abandoned mines is often acidic and can harm aquatic life. In addition, mine workers are subject to high temperatures, harmful dust and fumes, and persistent danger.

Fact/Issue	Level 3	<i>see also B4</i>	278
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Surface mining leads to deforestation, dust formation, reduced percolation of rain and increased runoff, erosion and landslides. In humid areas, it can lead to high acidity and heavy metal toxicity in soils and surrounding waters affecting both terrestrial and aquatic life.

Fact	Level 2	<i>see also B4</i>	279
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Surface mining damage can be repaired somewhat by replacing topsoil, adding organic fertilizers, and planting trees. Damage done to area surface waters, however, may be harder to repair.

Water	B2.2
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Issue	Level 1	<i>see also B4.1</i>	280
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The aquatic environment is subject to large scale use and abuse by people.

281 Issue Level 2 see also B1.2

Clean, sustainable water supplies have today become a rare commodity. Growing populations and industry are increasing our use of water, leading to conflicts when supplies fail to meet demands.

282 **Fact/Issue** **Level 2** *see also* **B1.2**

Nations are striving to provide adequate drinking water and sanitation for their people. Still, in 1986, 1.7 billion people in the world lacked access to potable drinking water, and 1.2 billion lacked adequate sanitation.

283 Issue Level 2 see also B1.3

Many nations do not have facilities for conserving their water resources. Rain water should be collected and stored well, without polluting it, to prevent serious water shortages in arid regions. Conservation techniques (e.g., afforestation of catchment areas) are important for water management.

284 **Definition** **Level 1** *see also* B2.3

A **WATERSHED** is the land area that collects and channels water to a common outlet. Each lake, river and stream collects its water from the surrounding watershed.

285 Issue Level 2 see also B1.4

Lack of watershed management has shortened the life-spans of many hydroelectric projects. The erosion of surrounding hillsides fills reservoirs with silt while releasing nutrients that encourage aquatic plant growth. Small-scale hydroelectric projects where entire watersheds can be managed may be the best alternative.

286 Opinion/Issue Level 3 *see also* B2.3

WATERSHED PLANNING requires a comprehensive plan for development and use of the water, soil and other resources in the watershed, even if divided by political boundaries. It should also consider the basic needs of the people living in that area.

Fact/Definition **Level 1** *see also A2.4* **287**

GROUNDWATER (water in underground reservoirs) is an important source of water for drinking, industry and agriculture. In the United States, groundwater reserves are estimated to be several times greater than all fresh surface waters, including the Great Lakes, and provide one-fifth of all water used. Groundwater is important as a perennial reservoir that regulates water supplies in streams, lakes and rivers.

Definition **Level 1** *see also A2.4* **288**

The WATER TABLE is the upper level of groundwater in an area, below which all material is saturated with water.

Definition **Level 1** *see also A2.4* **289**

An AQUIFER is a geologic formation which contains usable amounts of groundwater (accessed from a well or spring). Unconsolidated gravel or sand, and rocks with high porosity and permeability, make good aquifers. Aquifers are usually recharged in hilly or mountainous catchment areas, and the water moves through them to low-lying discharge areas.

Fact **Level 2** *see also A2.4* **290**

When water is removed or diverted from a waterway, groundwater recharge is affected and water supplies may suffer in the long term.

Definition **Level 2** *see also B2.3* **291**

SALT INTRUSION occurs when groundwater supplies are depleted to the extent that coastal waters infiltrate local aquifers. SALINIZATION occurs when salts accumulate on the surface due to prolonged water-logging of soils, usually from excessive or improper irrigation.

292 **Fact/Issue** **Level 2** *see also* **B4.2**

People's waste (sewage, garbage) accelerate the process of eutrophication in water systems and lead to disease. If these nutrients were treated or returned to the soil instead of the waterways, these problems would be reduced.

293 **Definition** **Level 2** *see also* **B4.2**

WASTE-WATER TREATMENT involves the removal of pathogens (disease-causing organisms) and soluble and non-soluble materials from waste water before releasing it into the environment.

294 **Fact/Issue** **Level 2** *see also* **B4.2**

Inadequate waste water treatment and lack of drainage are factors in the spread of diseases like malaria. In many developing countries the lack of potable water has led to the endemic occurrence of dysentery, typhoid and other diseases.

B2.3 **Land & Soil**

295 **Fact** **Level 1** *see also* **A2.3**

Land is an essential component of environment. It harbors soil, water, air, life forms and the systems within which they interact. The land is an important source of food and water. It is the structural component of all terrestrial habitats.

296 **Fact** **Level 1** *see also* **C3.1**

Land is both a public and a private commodity. It is, for the most part, permanent and fixed in supply. Its value depends largely on commercial actions and social customs.

Definition **Level 2** *see also* **A2.3** **297**

LAND USE refers to the way in which we harness the potential resources of a given area. Categories of land use may be based on current use (e.g., agriculture, forestry, industry) or potential use (based on surveys of topography, soil type, etc.). LAND-USE PLANNING is the use of this information to make decisions about long-term use of the land for maximum community benefit.

Issue **Level 2** *see also* **B4.1** **298**

The most immediately profitable use of the land is not always the best use in terms of its long-term health and ecology. For example, surface mining has led to considerable destruction of local and regional ecosystems.

Issue **Level 3** *see also* **B1.4** **299**

The effects of land use tend to be cumulative. We therefore have an obligation to future generations to minimize our negative impact on the land.

Fact/Issue **Level 2** *see also* **B4.1** **300**

Land is misused through deforestation, overgrazing, overcropping, intensive irrigation, and other forms of mismanagement and poor land-use practices. These can result in erosion, reduced groundwater recharge, deterioration of soil quality, salinization, lower crop yields, heavy siltation of surface waters and flooding of low-lying areas.

Fact **Level 2** *see also* **B2.1** **301**

Mining and quarrying activities cause significant damage to the land. Land reclamation, for example by replacing topsoil and planting trees, can help reduce long-term damage. Reclamation is expensive, however, and is often poorly completed if done at all.

302 Issue/Opinion Level 3 *see also* C1.4

Landlessness is a cause of urban migration, unemployment and poverty in many countries. Resettlement and land reform can reduce landlessness in the short run, but population stabilization is needed for long-term success.

303 Fact Level 1 *see also* C3.2

Land tenure has to do with the laws, customs and practices governing the rights, duties and relationships of people to the land.

304 Issue Level 3 *see also* B1.4

As pressures on our land resources increase, it will be necessary to use the same piece of land in a number of ways at the same time. Future land-use planning will have to emphasize sequential or multiple land use rather than exclusive use. This is already the practice in many societies (e.g., Indonesian rice paddies that also serve as fish ponds).

305 Opinion Level 3 *see also* B1.4

Planning for the future of land is planning for partnership with it. Satisfying today's needs should not compromise the ability of the land to sustain us tomorrow.

306 Opinion Level 2 *see also* C4.4

Comprehensive information on land -- its characteristics, tenure, use and legislation -- should be collected and constantly updated, for the use of both private citizens and the government.

307 Opinion Level 2 *see also* B4.3

Land management planning is most effective when done at a local level, based on the people's needs and with their active participation.

Fact **Level 1** *see also* **A2.3** **308**

Productive soils are complex mixtures of interacting gases, water, minerals, microbes and organic matter.

Fact/Issue **Level 3** *see also* **B1.3** **309**

Soil takes tens or hundreds of years to develop. Although traditionally taken for granted as an infinite resource, soil must be considered a nonrenewable resource and conserved accordingly.

Issue **Level 1** *see also* **A2.3** **310**

Conserving soil is vital to everyone because we must have soil to produce our food and clothing.

Fact **Level 1** *see also* **A2.3** **311**

The type of soil determines how land should be used (for example, if farmland, how it can be plowed and irrigated, its erosion potential, and the types of plants which could be successfully cultivated).

Fact/Issue **Level 2** *see also* **B4.0** **312**

Human activities (agriculture, deforestation), particularly in hilly terrain or arid regions, can lead to the destruction of soil structure and fertility. Some of the factors leading to a breakdown in soil are lack of vegetative cover, inappropriate irrigation, excessive use of chemical fertilizers, improper crop management and pollution from pesticides.

Fact/Issue **Level 2** *see also* **C2.1** **313**

In many agriculturally advanced nations, gains in food production have come at the expense of topsoil (e.g. through excessive erosion and nutrient depletion). If this trend is not stabilized, or if soils are not occasionally revitalized by the planting of nitrogen-fixing species (such as legumes), even fertile soils will succumb to degradation in the long run.

314 Fact/Issue Level 2 *see also* C2.1

Soil productivity can be maintained by reducing or preventing erosion, returning plant and animal residues to the soil, reducing the loss of plant nutrients, and adding minerals which are deficient.

315 Fact/Issue Level 3 *see also* B1.3

Severe soil erosion by wind or water has affected many areas. Soil erosion can be controlled through a variety of forestry and agricultural practices. Planting trees on slopes, and reducing agricultural soil loss by using contour cultivation, strip cropping, terracing and diversion channels, are some examples.

316 Opinion Level 3 *see also* B1.3

We cannot survive the continued wholesale loss of our topsoil. Maintaining soil productivity is essential to the welfare of all nations and future generations.

B3
Biotic
Resources

B3.1 Forests

317 **Fact** **Level 1** *see also* **C1.2**

Forests are important to us in that they furnish food, medicines and wood for fuel, timber and paper. They also form a part of the global ecosystem that supports us and of which we are a part.

318 **Fact/Issue** **Level 2** *see also* **B1.4**

Forests have traditionally been exploited for timber, fuelwood, foodstuffs, spices and other products, and more recently for raw materials for chemical and paper industries. Forest use has often been on an unsustainable basis.

319 **Fact** **Level 2** *see also* **B3.2**

Forests contain important wildlife and genetic resources and afford important aesthetic, recreational and scientific values.

320 **Fact** **Level 1** *see also* **B2.2**

Forests perform different functions in different terrain. In hilly areas they regulate the water supply, feeding springs and streams gradually. In level areas forests are important in drainage, reducing "swampiness."

321 **Fact** **Level 1** *see also* **A3.1**

Trees can serve as acoustic and visual screens around busy highways, noisy industrial installations and human settlements.

Fact/Issue **Level 2** *see also B2.2* **322**

Water quality and quantity in streams and aquifers depend to a large extent on forest cover. Where the cover is maintained, rainwater infiltrates the soil, streams are fed gradually by subsurface flows of relatively clean water, and aquifers are recharged by deep infiltration. Where forest cover is removed, especially on sloping land, more of the rainwater becomes surface runoff and streams are filled suddenly with silt-laden water. Sedimentation of stream beds and more erratic stream flows increase the frequency and severity of floods.

Fact **Level 1** *see also C2* **323**

Most of the world's best cropland was once forest land. Deforestation began as more lands were needed for agriculture and human settlements.

Fact/Issue **Level 2** *see also B4* **324**

DEFORESTATION (clearing an area of all trees) affects our environment in the long and short run. It is an immediate loss of wildlife habitat and natural resources. Long-term effects may include desertification and climate change.

Issue **Level 1** *see also B1.3* **325**

Existing forests need to be managed wisely if we are to continue to enjoy the benefits of tree resources.

Fact **Level 1** *see also A3.1* **326**

One-third of the forests in the world are CONIFEROUS forests. These forests are generally located in north temperate regions with cool summers and cold winters. Coniferous forests have great economic importance for timber and paper production.

327 **Fact** **Level 2** *see also* **A3.1**

TROPICAL RAIN FORESTS, with their rich variety of vegetation and animal life, are climax communities resulting from extensive development periods. They are valuable for their genetic resources, timber and other products. Most of the nutrients in these forests are in the vegetation itself, and soils are generally poor. Hence, use of forest land for agriculture is limited.

328 **Fact** **Level 3** *see also* **C1.3**

Rainforests are among the most diverse ecosystems, and the most threatened by human activities. They cover only six percent of the earth's surface, but contain over 50 percent of the earth's species. At present there are only 900 million hectares of the 1.5 billion hectares that once stood, and this is disappearing rapidly as humans clear forests for timber and agriculture.

329 **Fact** **Level 2** *see also* **B3.2**

MANGROVE FORESTS dominate about 75 percent of the earth's tropical coastline where rivers flow to the ocean. They harbor a unique flora and diverse fauna. They protect the coastline, prevent erosion, and are nurseries for marine organisms. They are also a source of fuel and fodder.

330 **Fact** **Level 2** *see also* **B4**

The greatest threats to the mangrove ecosystems are clear-cutting for timber and fuelwood, agriculture and aquaculture, diversion of freshwater from the watershed, and pollution. Only one percent of existing mangroves are protected world-wide.

331 **Issue** **Level 2** *see also* **C4.3**

AFFORESTATION (planting trees) is of vital importance in barren areas. But afforestation and reforestation efforts are often hampered by such factors as lack of local participation in decision-making and inadequate management efforts, which can result in the premature cutting or grazing of new plantings.

Fact **Level 1** *see also B3.2* **332**

In moderate numbers, herbivores cause little damage to forests, and may actually help plant regeneration. But too many animals continually removing foliage can kill trees. In newly planted areas, animals can keep trees from regrowing by eating or trampling seedlings.

Issue **Level 3** *see also C1.2* **333**

Indigenous groups with traditional lifestyles often have close, harmonious relationships with forests. The forests are a part of their cultural and social fabric. Most of their foods, medicines, and other materials come directly from the forest. Management of forests should be such that it creates confidence and trust among these people and gives them a sense of involvement.

Definition/Issue **Level 2** *see also C4.3* **334**

COMMUNITY FORESTRY considers the needs of local people first. Successful community forestry requires that foresters help people plant trees around their homes, farms and villages, as well as along canals and roadsides. It also requires public participation in decisions on where and what to plant, for what purposes, and how to harvest and distribute the products.

Definition **Level 2** *see also C2.1* **335**

AGROFORESTRY means growing trees in close association with crops, either in rotation with them or interspersed among them. It is a means of providing both wood for fuel and construction, and crops for food. Agroforestry is based on principles of natural ecosystems, and can help increase soil fertility and decrease pests.

Opinion **Level 2** *see also A4.3* **336**

Trees traditionally used for a variety of purposes and best adapted to their local habitat are preferable to exotic species in social forestry schemes.

Eucalypts (trees of the genus *Eucalyptus*) are one of the best known and most versatile groups of tree species. There are roughly 500 known species, adapted to a broad range of soil and climatic conditions. Eucalypts have been introduced all over the world -- some at high altitudes, some in near deserts -- where few other trees can survive.

The extensive use of eucalyptus trees in reforestation programs has raised many issues. Their growth in nutrient- and water-poor soils to provide a dependable cash crop has met with success. Yet their depletion of soil nutrients, heavy water consumption, and failure to provide fuel and fodder for local needs have led to criticism.

WILDLIFE refers to all animals and plants that are not domesticated. Wildlife is found everywhere: forests, parks, lakes, streams, school grounds, farms, cities and towns.

Wildlife provides important ecological functions, recreational value, and economic returns. Wise management must be applied if we are to continue to enjoy the benefits we now receive from wildlife.

Industrial products derived from wildlife include gums, oils, resins, dyes, tannins, vegetable fats, waxes, insecticides, starch and detergents.

Fact/Issue **Level 2** *see also B3.3* **342**

All over the world there has been a drastic decline in wildlife due to human activities. About 120 species of mammals and about 225 species of birds have become extinct since we began to keep track. Another 650 species of birds and mammals, as well as countless plants and insects, are in danger of extinction.

Fact/Issue **Level 2** *see also B1.3* **343**

International trade in wildlife (for zoos, pets, and laboratory research) and wildlife products (furs, skins, feathers and horns, and museum specimens) has decimated the populations of many species. The more rare a species becomes, the more valuable it is to collectors. The battle between poachers and park officials over the ivory of the remaining African elephants in Kenya, for example, has become an all-out war.

Issue **Level 3** *see also C4* **344**

Many wildlife species face extinction due to habitat destruction and exploitation of the species by humans. Protection of these species requires legislation to restrict their use (e.g., prohibiting import and export of ivory), as well as education to remove misconceptions (e.g., that the horn of the black Rhinoceros has medicinal properties).

Fact/Issue **Level 2** *see also B1.3* **345**

The creation of national parks and wildlife sanctuaries is an attempt to manage wildlife by defining protected areas. Human activities such as resource-gathering are restricted in and around these areas. Wildlife is regularly monitored and the necessary management strategies formed and implemented.

Fact **Level 3** *see also C1* **346**

Wildlife sanctuaries and national parks are not only for the benefit of wildlife, but indirectly for human benefit. They may serve as protectors of entire ecosystems.

To manage wildlife, it is necessary to manage the ecosystem. One species cannot be preserved in isolation; it depends on and is depended upon by the other species with which it interacts. For example, the snow leopard can only be protected if its prey, and all preceding links in the food chain, are also protected.

Maintenance of productive habitats is one of the most effective tools for wildlife management.

Regular monitoring of wildlife species and habitat is essential to ensure their conservation.

BIOSPHERE RESERVES are areas that integrate several zones based on various levels of human activity. A reserve usually consists of a **CORE AREA**, where no human disturbance is permitted, a surrounding **BUFFER ZONE** from which local people may draw limited resources, and a **FREE ZONE** which is open to settlements and resource gathering. Biosphere reserves are based on the principle that we can protect our natural resources while still providing for people's needs.

Maintaining buffer zones around national parks for sustainable use by local people is an important management strategy. Educating the local people on the importance of preserving wildlife and other natural resources is an integral part of wildlife management.

Fact/Issue Level 3 *see also* C4.2 352

Parks and nature reserves must be established with regard to local cultural values, fears and needs. Parks should not be island fortresses. With limited funds and staff, it is difficult to protect a reserve from surrounding human pressures, unless these people's needs have been incorporated into the park structure. Education about the park and provision of a usable buffer zone are actions which will strengthen local support of the park. Local expertise on the ecology, wildlife, and uses of area plants could be incorporated into the park structure.

Issue Level 2 *see also* B1.3 353

Planning can eliminate, or at least minimize, many of the "harmful" effects wildlife has on people. For example, maintaining the Indian tiger's natural prey population and making provision for adequate cattle grazing areas away from tiger reserves may reduce the incidence of tigers preying on cattle or attacking humans.

Issue Level 3 *see also* A5.4 354

Several wildlife management strategies should be incorporated into a comprehensive plan for management of a species. For example, hunting regulations on their own will not work to save a species whose habitat has been destroyed or seriously depleted. In India, Project Tiger involved the improvement and expansion of suitable habitat as well as restrictions on human activities such as hunting, grazing and agriculture. The project has not only saved the tiger, but numerous other inhabitants of the Indian wilderness as well.

Fact/Issue Level 2 *see also* A4.3 355

We have introduced exotic species into areas where they have no natural predators. They have then encroached upon local (endemic) species, and in some cases completely replaced them. For example, on the Andaman Islands of India, the introduced common mynah and house sparrow are displacing local bird species.

356 Fact/Definition Level 2 *see also* A4.3

REINTRODUCTION is the release of an animal or plant species into an area in which it was once indigenous, but has since declined or disappeared. Reintroductions are particularly useful where a population has declined due to over-hunting or habitat deterioration. To be successful, the original pressures leading to species decline must be removed (e.g., prohibit hunting or restore habitat) before reintroduction occurs.

357 Fact/Issue Level 3 *see also* B1.3

Wildlife ownership is vested in the state. The government (at both the central and state levels) handles legislation, management and research related to wildlife. However, there is much concern and participation in wildlife conservation from individuals, local groups, and national and international organizations.

358 Fact/Issue Level 2 *see also* B4

Natural wetland areas support a rich variety of bird life. Depletion of these wetlands through agriculture, urbanization or pollution may force these birds to change migratory routes or may lower their populations.

359 Fact Level 2 *see also* B4.1

CORAL REEFS are areas of high productivity and diversity of species. One-third of all fish species in some way depend on coral reefs. Reefs are also crucial for protection of coasts against erosion. Sediment pollution (silt), and destruction by blast fishing and mining are the main threats to reefs. Water pollution and over-fishing are other factors contributing to the decline of these important ecosystems.

360 Definition Level 1 *see also* B2.2

ESTUARIES are indented portions of coastlines where rivers meet the sea. Their mixture of fresh and salt water supports diverse marine, estuarine and freshwater life.

Biotic Resources

B3.2

Fact	Level 1	<i>see also B2.2</i>	361
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One-third of the world's population lives in such proximity to the coast as to impact coastal ecosystems.

Fact	Level 2	<i>see also B1.3</i>	362
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Fisheries resources are best preserved by protection of spawning and feeding habitats.

Issue	Level 3	<i>see also B1.3</i>	363
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The public needs to recognize the dangers that pollution and other pressures have put on fisheries. Support of fisheries research and enforcement of fisheries and pollution regulations (such as limits on harvest and waste disposal) are also needed.

Biodiversity B3.3

Definition	Level 1	<i>see also A3</i>	364
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The BIOLOGICAL DIVERSITY (BIODIVERSITY) of life refers to the biosphere's genetic material, contained within the rich variety of life forms with which we share this planet.

Issue	Level 2	<i>see also B1</i>	365
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Biodiversity is important for the continued well-being of the earth and its inhabitants. The greater the number of existing species, the more resilient the biosphere and its ecosystems remain. Greater diversity also means more possibilities for selection of natural resources.

Fact/Issue	Level 2	<i>see also C2.1</i>	366
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The earth's biodiversity is the source of our most essential products (food, many medicines, fabrics, etc). Loss of this diversity has major implications for agriculture and industry.

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| 367 | Fact | Level 2 | <i>see also</i> B1 |
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- There is vast potential for developing new sources of food, medicine and other essentials, or improving existing sources, by tapping into earth's biodiversity resources.
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| 368 | Issue | Level 2 | <i>see also</i> C1.3 |
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- Global biodiversity is rapidly decreasing through deforestation, improper agricultural practices, pollution and other human-caused factors.
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| 369 | Fact | Level 2 | <i>see also</i> A5.0 |
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- The greatest diversity of species exists in mature, undisturbed ecosystems. It is estimated that, of the five to ten million species thought to inhabit the earth, over half live in the tropical rain forests.
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| 370 | Fact | Level 1 | <i>see also</i> B2.2 |
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- Oceans support a diversity of plant and animal life, from single-celled algae, to fish, to the giant blue whales, the largest mammals on earth.
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| 371 | Opinion | Level 3 | <i>see also</i> C1.1 |
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- As human beings, we are a part of the diversity of life, and are responsible for maintaining it.
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| 372 | Fact | Level 3 | <i>see also</i> B1.3 |
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- BIOSPHERE RESERVES are areas set aside specifically for the preservation of biodiversity. The main objectives are to conserve wild genetic resources within their natural ecosystems, allow evolutionary processes to operate unhindered, and provide opportunities for ecological and environmental research and education.
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Fact **Level 2** *see also C3.3* **373**

The present concern over preserving genetic resources in biosphere reserves is similar to the "sacred grove" concept in India. These religious land reserves conserve examples of biological communities within areas that have otherwise lost this diversity.

B4

Degradation
of Resource
Base

Limits to Systems B4.1

Fact/Definition	Level 2	<i>see also</i> A5.0	374
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A NATURAL THRESHOLD is the amount of stress a natural system can withstand before it collapses or changes. For example, temperate forests may be driven past pollution limits, or tropical forests below critical moisture levels. Soil is driven past its threshold when the rate of erosion exceeds the rate of formation.

Fact/Issue	Level 3	<i>see also</i> A5.0	375
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The thresholds of natural systems are not well understood, and the consequences of crossing them are not known. Threshold effects now seem to be appearing in some natural systems (forests dying from acid rain, increasing desertification, etc.).

Opinion/Issue	Level 2	<i>see also</i> C1.4	376
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There is a maximum population matched to each resource base. Population cannot exceed this level if a satisfactory standard of living for all people is to be maintained.

Fact/Issue	Level 2	<i>see also</i> B4.2	377
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Natural systems and processes have limited capacities to cycle or disperse pollutants. Some pollutants, such as organic wastes, are decomposed in weeks or months. Certain substances (chemicals, plastics, and radioactive wastes) may not be broken down for decades, if ever.

Fact/Issue	Level 3	<i>see also</i> B3.2	378
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Water pollution, destruction of spawning areas, inadequate regulation of harvest, and intensive fishing methods have disrupted many aquatic ecosystems and contributed to a sharp decline in aquatic organisms. This has deprived many fishermen of their livelihood and people of a much needed food.

379 **Fact/Issue** **Level 3** *see also* **B2.2**

The oceans are vast but not limitless. We have severely impaired the productivity and sustainability of ocean ecosystems through inappropriate technology and pollution. For example, oil tankers now spill an estimated 1.5 million tons of oil per year into the sea.

380 **Definition** **Level 1** *see also* **B2.3**

DESERTIFICATION is the process by which fertile areas become arid land or desert through land mismanagement or climate change. In extreme cases, the loss of vegetation and topsoil leads to a total destruction of the land's ability to support life. Desertification threatens over 600 million people and 35 percent of arable land in the world.

381 **Fact** **Level 2** *see also* **B1.3**

Desertification can be ameliorated through afforestation and agroforestry, using suitable plant species, soil conservation techniques and watershed management.

B4.2 **Pollution**

382 **Definition** **Level 1** *see also* **C1.3**

POLLUTION is any addition of unwanted substance to or alteration of the environment that adversely affects human health or living systems.

383 **Fact** **Level 1** *see also* **C2**

Environmental POLLUTANTS include: nutrients, acids, toxic elements (including heavy metals), organic compounds, pathogens, particulates, gases, heat, radiation and noise.

Definition **Level 2** *see also* **A4.2** **384**

Pollutants may be BIODEGRADABLE, NON-BIODEGRADABLE, or SLOWLY DEGRADABLE. Biodegradable pollutants are nutrients and other materials easily broken down and absorbed by the environment. Non-biodegradable pollutants, such as the polychlorinated biphenyls (PCBs) and dioxins, do not degrade into harmless components. Slowly degradable pollutants like plastics decompose after many years.

Fact **Level 2** *see also* **A4.2** **385**

Pollutants can be nutrients, natural or artificial, which are not toxic in themselves but which may be harmful when introduced into the environment faster than they can be removed by natural processes.

Fact **Level 2** *see also* **B1.3** **386**

Natural resources may be rendered useless by pollution even before use (for example, groundwater contaminated by pesticides).

Fact/Issue **Level 2** *see also* **A1.3** **387**

Each pollutant has its own origin, pathways and effects, but all can spread throughout the biosphere by air, land or water.

Fact/Definition **Level 2** *see also* **B2.2** **388**

WATER POLLUTION occurs when chemicals or nutrients are placed into water faster than they can be removed by natural processes. Sewage, oils, excess silt, industrial chemicals and heavy metals are dumped into water. In addition, chemicals from the air dissolved in rain water, and pesticides and fertilizers leached from land, run off into water.

389 Fact Level 2 see also B2.2

The major water pollutants are organic wastes, pathogens, nutrients, synthetic organic compounds, oils, heavy metals, radioactive materials and heat. All of these pollutants can have serious implications for human health.

390 **Definition** **Level 2** *see also* B2.2

Water pollution comes from POINT and NON-POINT sources. Point sources are pipe outlets and other direct and observable sources of pollution. Non-point sources include run-off of fertilizers, acid precipitation, and other large-scale "blanket" sources. These pollution sources are less easy to identify and control.

391 **Fact/Issue** **Level 2** *see also* B2.2

Pollution in lakes, streams and rivers can often be traced to run-off from their watersheds. If the watersheds are deforested, there is likely to be heavy siltation. Watersheds in agricultural areas may contain residues of pesticides, fertilizers and other chemicals which leach into water bodies.

392 Fact Level 2 *see also* B2.1

In spite of controls to minimize spills, offshore and terminal oil operations contribute pollution to surrounding waters. Likewise, oil refineries emit significant quantities of pollutants into air and water.

393 **Fact/Issue** **Level 2** *see also* B2.2

We cause water pollution by allowing biotic and abiotic contaminants to enter the water. Individual and community sanitation, along with control and treatment of human and industrial wastes, are necessary to reduce water pollution.

394 Fact Level 2 *see also* B2.2

Stagnant waters (lakes and ponds) are more easily polluted than flowing waters (rivers and streams) because the water is not renewed as quickly and pollutants can accumulate.

Fact/Definition Level 1 *see also* B2.2 395

Waste heat , a byproduct of many industrial processes (e.g., power generation) is released as heated water. THERMAL POLLUTION occurs when this raises water temperature so that it harms aquatic organisms or changes the balance of aquatic ecosystems.

Fact Level 2 *see also* B2.2 396

Pollution of an aquifer may result from disposal of wastes on the land surface or in the ground. It can also result from overpumping of ground water in coastal areas, which leads to intrusion of salt water into freshwater aquifers.

Fact Level 2 *see also* B2.2 397

Groundwater is less easily polluted than surface water because pollutants are filtered out as water passes through soil. However, when groundwater does become polluted, it is more difficult to detect and clean.

Fact Level 3 *see also* B2.2 398

Groundwater is more susceptible to pollution in areas with sandy soils, high water tables, or abundant rainfall. High soil porosity means poor filtration, high water tables prevent adequate percolation time, and abundant rainfall serves to leach pollutants from surface soils.

Definition Level 2 *see also* A2.2 399

There are two main types of AIR POLLUTANTS: primary and secondary. PRIMARY pollutants are those emitted directly into the air, such as particulates, oxides of nitrogen, hydrocarbons, sulphur dioxide and carbon monoxide. SECONDARY pollutants are those produced from the chemical interactions of primary pollutants with other atmospheric compounds.

400 Fact/Issue Level 3 *see also* A2.2

The burning of fossil fuels emits sulphur and nitrogen oxides into the air. These pollutants combine with moisture in the atmosphere to form sulphuric and nitric acids which fall as ACID PRECIPITATION (rain or snow). Acid rain adversely affects lakes, forests, wildlife, agricultural land, water supplies and human health.

401 Fact/Definition Level 2 *see also* A3.1

PARTICULATES are small particles (such as dust and soot) in the atmosphere that contribute to air pollution. They are released by natural (volcanic eruptions) and artificial (burning of coal) processes. Particulates can cause respiratory problems by entering the lungs. Particulates deposited on the surfaces of plant leaves interfere with photosynthesis and other physiological functions.

402 Fact/Issue Level 3 *see also* C2.3

Pollutants can have serious long-term effects on the biosphere. For example, the accumulation of chlorofluorocarbons (CFCs) in the upper atmosphere is thinning the ozone layer, increasing our exposure to ultraviolet radiation. This could lead to increased rates of skin cancer, and damage to natural and artificial ecosystems (including agriculture). CFCs are produced in the manufacture of foam and are used as propellants in aerosol spray cans (although they have been banned for this use in the US).

403 Fact/Issue Level 3 *see also* C1.3

Long-term effects of pollution include climatic changes. The GREENHOUSE EFFECT is a predicted warming of the earth's atmosphere caused by increased atmospheric levels of carbon dioxide and other gases. These gases (largely byproducts of the burning of fossil fuels) form a layer which traps heat in the atmosphere. Rising temperatures may warm the oceans enough to raise sea levels, with serious consequences for the one-third of the human population living in coastal areas. Changes in climate could also drastically affect world weather patterns and agriculture.

Issue **Level 2** *see also C2.3* **404**

Many modern industrial processes use hazardous substances or TOXICS. Safe use of these substances and safe disposal of TOXIC WASTES are issues facing all nations.

Fact **Level 3** *see also A5.1* **405**

Pollutants and toxic substances present in low concentrations in the environment (mercury, lead, etc.) can accumulate to critical or lethal levels at higher trophic levels through biomagnification.

Opinion **Level 3** *see also C2* **406**

Whenever possible we should use safer, more environmentally sound replacements for synthetic substances in industry and agriculture. For example, pesticides which rapidly break down into harmless compounds should be used instead of those which stay in the environment for years as toxic compounds.

Fact/Issue **Level 2** *see also B2.1* **407**

Nuclear power generation produces concentrated radioactive waste for which there is no adequate disposal method. Nuclear power accidents can release radiation into the atmosphere, possibly leading to serious health and environmental problems. Nuclear power production also generates large amounts of waste heat which is discharged along with coolant water causing thermal pollution.

Fact/Issue **Level 3** *see also B2.1* **408**

Radioactive pollution has occurred in the oceans, atolls and deserts where nuclear weapons testing has taken place. In some areas, for example certain islands in the South Pacific, this radiation has caused long-term health problems for local populations.

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|------------|-------------------|----------------|-----------------|
| 409 | Fact/Issue | Level 1 | <i>see also</i> |
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- NOISE POLLUTION can cause physiological damage to the human ear as well as considerable mental strain. Continuous noise from streets, factories and even loud celebrations can cause permanent hearing losses.
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| 410 | Issue | Level 1 | <i>see also C4.1</i> |
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- VISUAL POLLUTION is the degradation of a landscape's aesthetic quality. Examples of visual pollution are billboards along highways, garbage in the street, and signs of human presence in wilderness areas.
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| 411 | Fact | Level 2 | <i>see also C2.3</i> |
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- As a nation develops its industrial base, its pollution tends to increase in quantity, variety and toxicity.
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| 412 | Issue | Level 2 | <i>see also C1.1</i> |
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- Our health is a reflection of the quality of our environment. For good health our environment should provide access to clean air, food, water and living space.
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| 413 | Fact | Level 3 | <i>see also C4</i> |
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- Pollution causes stress to both the mind (visual and noise pollution) and the body (air pollution, etc.). Stress-related illnesses include high blood pressure, ulcers, and a variety of psychological disorders. Illnesses due to physical pollutants include cancer, lung disease and neurological disorders.
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| 414 | Fact/Issue | Level 3 | <i>see also C4</i> |
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-
- Pollutants accumulate in our bodies from a combination of sources: the air we breath, our food and our water. This can result in SYNERGISTIC or cumulative effects. When calculating the effects of pollution, synergistic effects are seldom considered.
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Fact **Level 1** *see also C4.3* **415**

The trash we throw in the streets, fumes from our vehicles, and wastes from our factories cause pollution and create health problems for all of us.

Issue **Level 2** *see also C4.1* **416**

Some pollution costs, such as poor health, cannot be fully expressed in economic terms.

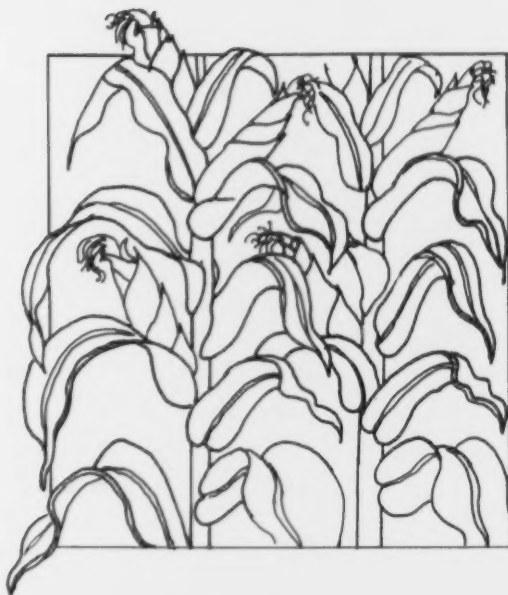
Opinion **Level 3** *see also C4* **417**

Preventing pollution costs less financially and environmentally than cleaning up after it has occurred.

Opinion **Level 3** *see also C4* **418**

The most important factor in the prevention and control of pollution is education and the resulting changes in people's values, attitudes and behavior.

C



HUMAN
SYSTEMS

C1
Humans
and
Environment

C1.1 Humans as part of environment

419	Opinion	Level 1	<i>see also C4.1</i>
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We must consider ourselves a part of the environment, not apart from it.

420	Fact/Issue	Level 2	<i>see also C3</i>
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The environment is a dimension that affects all aspects of our lives (physical, biological, social and cultural). Our survival depends on our interaction with the environment.

421	Fact	Level 1	<i>see also A1.3</i>
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We are all part of the biosphere and are supported by it. It is the sole source of food, energy, and shelter for all people on earth.

422	Opinion	Level 3	<i>see also A1</i>
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We think of the biosphere as a source when it is a system. We alter it rather than integrating with it. We think of it in terms of our needs, rather than the needs of all life forms. But we are members of the biosphere, not its consumers.

423	Issue	Level 2	<i>see also C4</i>
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As the quality of the environment improves, so does the quality of human life.

424	Opinion	Level 1	<i>see also C4.1</i>
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Nature is ordered, balanced and harmonious; human beings, like all living things, have a place and purpose in this order.

Human adaptation to environment C1.2

Fact/Issue	Level 2	<i>see also</i> B4	425
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Our well-being is dependent on the environment. If we allow the quality of our environment to deteriorate, ultimately the quality of the human condition will also decline. This decline may be gradual or abrupt, perceived or unrecognized, permanent or repairable.

Opinion	Level 2	<i>see also</i> C4	426
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We need the environment in more than material ways. It provides recreation and spiritual and creative inspiration.

Fact	Level 1	<i>see also</i> A4.3	427
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Humans have evolved with their changing environment.

Fact	Level 2	<i>see also</i> C3.3	428
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The environment has produced biological variations and cultural differences in human populations.

Fact/Issue	Level 3	<i>see also</i> C2.3	429
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As humans has advanced technologically, we have tried to manipulate our environment to suit our needs. But today, as we reach what appear to be critical thresholds of the biosphere, we are realizing that we must adapt to the environment, and not vice versa.

Humans, like all species, must adapt to their environment or die. As we take a greater hand in the condition of the environment, we must decide which is less costly: reducing our negative impact on the biosphere or living with the damage. Modifying our behavior is the next step in our evolution.

Humans have been present for only a small fraction of total geologic time. In spite of this, humans have had a greater impact on the earth's environment than any other single species.

Humans are unique among organisms in the degree to which they can manipulate their environment.

All human activities, from primitive farming to the most recent technological innovations, cause some change in our environment, impacting the biosphere and its resource base.

One of our greatest impacts on the environment is the destruction or alteration of natural habitat.

Individually and collectively people are capable of significantly altering cycles and systems of the earth. For example, deforestation throughout the world is believed to have affected climatic patterns.

Fact/Issue	Level 2	<i>see also B4</i>	436
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Some of our environmental impacts are large-scale and may be irreparable (the loss of topsoil, depletion of the ozone layer, the greenhouse effect).

Issue	Level 2	<i>see also B1</i>	437
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Our lifestyle can affect the environment in significant ways. Highly consumptive lifestyles have great impact on the environment through their extensive use of resources. Even simple lifestyles can affect the local environment.

Fact/Issue	Level 2	<i>see also C2</i>	438
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Industrialization, population growth and depletion of natural resources have affected our environment. Most of the earth's habitable surface has been altered by humans plowing plains, cutting trees, and building cities, roads and reservoirs.

Issue	Level 3	<i>see also B4.1</i>	439
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We alter the environment gradually (introduction of a persistent pesticide) and abruptly (clearing a forest). Some of these alterations result in immediate and obvious environmental problems, while other effects are subtler and more long-term.

Opinion	Level 1	<i>see also A1</i>	440
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Nature left undisturbed achieves a state of dynamic equilibrium--a harmony of form and function. We often disturb this balance.

Fact/Issue	Level 2	<i>see also A4.1</i>	441
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The occurrence of natural phenomena, such as floods and drought, and the magnitude of their effects have been accelerated by human activity.

Humans now have the capacity to destroy the biosphere (for example, with nuclear weapons).

People are capable of reducing and reversing their negative impact on the environment because they can think, plan and educate.

Humans have the ability to change their environment and collectively these changes influence the biosphere for good or for bad. What life is like on earth in the future depends on how we take care of it now. We should all strive to be good "caretakers" of the earth.

As human populations increase, their impacts on the environment also increase.

OVERPOPULATION occurs when the population exceeds the limit that the resource base can support without stress (its carrying capacity).

As human populations and their consumption levels increase, it becomes more difficult to attain and maintain environmental quality.

Issue **Level 3** *see also* **A5.3** **448**

The human population, like other populations, is ultimately limited by the biosphere's carrying capacity. At the beginning of this century, the global population was 1.6 billion. In 1986 it passed the five billion mark. Increases in population and consumption could, if unchecked, outstrip the capability of the biosphere to support life.

Fact/Issue **Level 2** *see also* **C2.3** **449**

Technological advances, such as more productive agricultural methods and better health care, have decreased infant mortality and increased longevity. In turn, these factors have led to rapid population growth.

Fact **Level 2** *see also* **C2.3** **450**

Modern medical technology has led to increases in human populations through decreased death rates.

Issue **Level 3** *see also* **A5.3** **451**

Increasing birth rates and declining death rates are changing the age structures of our societies. These changes need to be understood and planned for; for example, by providing health care for the elderly and education for the young.

Fact/Issue **Level 3** *see also* **C3.2** **452**

In the past, people migrated to new regions to alleviate overpopulation. Today the global ability to manage overpopulation through migration has been reduced, mainly because of strict immigration laws of many nations, and because there is less underpopulated territory.

453 **Fact/Issue** **Level 3** *see also C3*

Marriages later in life, access to birth control information, increased literacy and employment among women, and higher standards of living can help slow population growth. However, the social security value of children (i.e., the child's potential to provide for the parents) is still the over-riding concern for many, especially the poor.

454 **Issue** **Level 3** *see also C3*

Like many policies, policies on population have personal, social, religious, ecological, political and economic implications.

C2
Technological
Systems

C2.0

455	Fact/Issue	Level 2	<i>see also</i> A5.0
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Most natural ecosystems operate efficiently on available energy and materials. While primitive human systems were similarly adapted to their natural environments, modern systems require heavy subsidization of energy and materials.

C2.1 Agriculture

456	Fact	Level 1	<i>see also</i> B1.4
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Traditional agriculture in many parts of the world was labor-intensive, used organic fertilizers, and was ecologically sustainable.

457	Fact	Level 2	<i>see also</i> B1.4
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Some traditional agricultural practices, such as intercropping, are ecologically sustainable because they mimic ecosystem processes. However, practices such as shifting agriculture ("slash and burn") are now less sustainable as they require large amounts of land. While once suitable for small isolated groups, higher population densities now force farmers to return quickly to abandoned fields, resulting in soil exhaustion and environmental deterioration.

458	Fact	Level 2	<i>see also</i> B1.4
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Modern high-yield agriculture is a technologically sophisticated industry, depending on vast quantities of water, fertilizers, pesticides and hybrid seeds.

Fact/Issue **Level 2** *see also* **B1.4** **459**

Modern agriculture produces four times or more the yield per acre than traditional agriculture, but may require up to one hundred times the energy input.

Fact/Issue **Level 3** *see also* **B4.2** **460**

The introduction of synthetic fertilizers and pesticides in food production has had unanticipated negative effects: the cost of chemicals drives up the cost of production and food prices; land is exhausted when it is used year after year, with more and more additives needed to achieve the same yields; and some additives have toxic, mutagenic or carcinogenic effects. These are sometimes discovered only after years of use.

Fact **Level 2** *see also* **A5.1** **461**

The use of DDT (a pesticide now banned in the US) has adversely affected species at the top of the food chain because of BIOMAGNIFICATION. This is a process by which chemicals in the environment are concentrated in higher trophic levels. Larger organisms accumulate the most because they ingest numerous smaller organisms, which contain small amounts of the chemical (for example, a bird eating insects).

Issue **Level 1** *see also* **B4.2** **462**

Continuous long-term exposure to pesticides and chemical residues in food, water and air is hazardous. Each year thousands die from pesticide poisoning, while many more suffer acute illness.

Fact **Level 2** *see also* **B1.4** **463**

There are many environmentally safe means of increasing food production. BIOFERTILIZERS are inexpensive and ecologically sound alternatives to chemical fertilizers. Instead of urea, for example, nitrogen-fixing blue-green algae can be added to flooded rice fields. Some types of bacteria also enrich soils. Animal, plant and even human waste (after destroying pathogens) can be used to fertilize soils.

464 Fact/Issue Level 3 *see also* B1.4

IRRIGATION can lead to problems including water-logging, leaching of nutrients, and salinization of soils. Most modern irrigation methods are costly and resource-intensive, and waste large amounts of water to evaporation. Alternative systems of irrigation include the water-efficient Israeli trickle or drip system, where pipes slowly add water to the roots of plants, rather than spraying or flooding entire fields. Drought-resistant species and dry-land farming methods can be combined with or replace irrigation in some areas.

465 Issue Level 2 *see also* B4.1

Increasing demands for food have resulted in the farming of marginal and non-arable lands throughout the world. This has resulted in degradation of these environments, such as erosion and desertification.

466 Issue/Opinion Level 3 *see also* B2.3

Deep plowing and intensive cultivation are leading to soil erosion and depletion on a large scale. Crop yields on marginal lands are falling as soil structure, nutrients and moisture are lost. Rangelands have been permanently altered by livestock grazing, which leads to changes in plant communities and increased soil erosion. Soil conservation policies should encourage planting trees on slopes and poor soils, and letting marginal land go to fallow or be used for pasture. Equally important, urban growth should be curbed to slow its encroachment on productive farmland.

467 Fact/Issue Level 2 *see also* B2.3

Excess livestock, dwindling grazing lands, and lack of organized fodder production and pasture management have led to overgrazing in large parts of the world. Overgrazed lands are prone to soil erosion and desertification, especially in semi-arid and arid regions where raising cattle, sheep, goats and camels is an important way of life. Stall-feeding, rotational grazing (alternating pastures) and fencing fragile areas are some approaches to solving this problem.

Fact/Issue Level 2 *see also* B2.3 468

In many parts of the world, livestock grazing and fodder gathering cause more damage to woodlands than the cutting of fuelwood.

Fact/Issue Level 2 *see also* B2.3 469

Continuous farming in dry areas can lead to loss of soil nutrients and moisture, increased erosion and desertification. Reduced crop yields in arid and semi-arid areas is one reason many small farmers have abandoned cultivation.

Issue Level 1 *see also* B2.3 470

Increase in agricultural land area comes at the expense of the natural environment.

Definition/Fact Level 3 *see also* B1.4 471

Marginal farms can often be improved through REGENERATIVE FARMING techniques. INTERCROPPING (planting crops together which require different nutrients) fully utilizes the soil. CROP ROTATION between grains (which use nitrogen) and legumes (which replace it) restores nutrients. Regenerative farming requires less chemical fertilizers and pesticides to produce the same yields. Drawbacks are that these methods are labor-intensive and often unfamiliar to farmers.

Definition Level 3 *see also* B1.4 472

AGROFORESTRY is the planting of crops in combination with trees, a method that mimics natural ecosystems. Trees provide wood for fuel and construction and leaves for fodder while protecting crops from extremes of weather. Soil nutrients and moisture are better maintained in the cooler microclimate created by the trees. Trees and crops can be selected with complementary nutrient requirements (for example, nitrogen-replacing tree species with nitrogen-using grains). Agroforestry, when used properly, is both an ecologically and economically sustainable form of agriculture.

In many countries, the work animal fits organically into the agricultural system. Feed and fodder for the animal comes mainly from the village pasture or the farmer's own crops. The animal provides energy for plowing fields and transporting goods; its dung is used as fuel and fertilizer.

In developing countries, much of the energy input in farming originates in animal sources. Farmers use animal energy for plowing fields, drawing carts, irrigation, oil extraction and threshing.

By domesticating plants and animals, humans have altered the global gene pool -- both by selective breeding of some species for certain characteristics and by eliminating other species through planned eradication and destruction of habitat.

Humans have developed new strains of plants and animals through generations of selective breeding. BIOTECHNOLOGY is a new science which shortens this process by directly altering genetic material. This may lead to useful new strains of animals and plants. There are potential risks to biotechnology, however, because it is not known how the rapid introduction of new strains of organisms will affect the environment.

Gene banks of traditional and wild varieties of crops are essential to maintaining plant productivity. New varieties of high-yield crops are often developed using genes of wild plants to increase resistance to disease or make them suitable to various conditions.

Fact/Issue Level 1 *see also* A3.2 478

Loss of agricultural produce to pests and microorganisms is significant. It is estimated that rodents alone cause losses of up to 10 percent of harvested grain in developing countries.

Opinion Level 3 *see also* B1.4 479

Agricultural research should emphasize low-cost techniques for farmers in areas where rainfall is erratic or soils are poor. Emphasis should be on self-sufficiency of farmers, sustainability of agricultural systems, and conservation of soil and water resources. These principles should apply to all levels of farming in all countries.

Settlements C2.2

Definition Level 1 *see also* C3.2 480

People live in clusters of dwellings ranging in size from large cities to small towns and villages. We call these clusters HUMAN SETTLEMENTS.

Fact Level 2 *see also* C3 481

Human settlements were established originally for economic, social and protective reasons, and have resulted in the cultural and intellectual achievements we call civilization.

Fact Level 2 *see also* C1.2 482

Historically, the location of human settlements was strongly influenced by the environment. They were sited near sources of water and other natural resources, at crucial transportation points, and in well-protected or easily defensible areas. Today the presence of commerce and industry is also a significant factor in the establishment of settlements.

483 Opinion Level 2 see also C3.3

Every human settlement has its own character, a mixture of the values and styles of its inhabitants, its economics, its architecture and streets, and the landscape of which it is a part. There are no absolute criteria for saying whether a settlement's character is right or wrong.

484 Opinion Level 2 see also C1.1

Human settlements are a part of the environment. They are also environments in themselves. A good human settlement is a safe environment, not entirely removed from nature.

485 Opinion Level 3 see also C3.2

A human settlement should be a place for the development of the human potential. There should be places to work, to learn, to relax and enjoy nature, to meet, to play, and to develop and express creativity.

486 Fact Level 2 see also B4.1

Human settlements throughout history have ceased to grow or have declined when they reached the capacity of their resource base.

487 Fact Level 1 *see also* C1.4

Cities are characterized by high population density, high energy and material consumption, and the generation of large amounts of waste.

488 Opinion Level 3 *see also* C1.3

Cities represent people's greatest continuing impact on nature, the places where they have most altered the environment. The city is the quintessence of our ability to change our habitat.

489 **Fact** **Level 2** *see also*

A city must be designed to accomodate the flow of movement, with networks for various vehicles, trains, pedestrians and so on.

Definition **Level 2** *see also* **A5.0** **490**

URBAN ECOSYSTEMS are areas so highly stressed, they no longer resemble natural systems. They are a new type of ecosystem created by and for humans.

Fact/Issue **Level 3** *see also* **A5.0** **491**

Like any life-supporting system, a city provides a flow of energy and nutrient cycling. But because it is not self-sufficient, a city requires external sources of energy and materials, and a system of waste disposal.

Fact/Issue **Level 3** *see also* **B4.2** **492**

Pollution is more concentrated in urban areas because there are more people and more industries. City dwellers also generate more waste because they consume more per capita than the rural population. These wastes are often non-biodegradable, such as plastics. Also, the ecological systems that break down organic wastes are less efficient in urban areas (e.g, due to lack of soil microorganisms).

Fact **Level 1** *see also* **C2.3** **493**

URBANIZATION (growth of cities) is the result of a population's shift from direct resource-gathering activities (agriculture, fishing) to production-oriented activities (industry, services). The three components of urbanization are: migration from rural to urban areas; natural population increase (more births than deaths); and the reclassification of areas from rural to urban status.

Issue **Level 2** *see also* **B1.4** **494**

Migration into urban settlements will continue as long as people cannot meet their needs in rural areas or believe that the city offers the chance for a better standard of living.

495 Issue/Opinion Level 2 *see also* B1.4

Once people migrate to the city it is difficult for them to return to their homes, especially when their land ties have been lost. Long-term development planning, such as increasing employment in rural areas, is needed as rural land-use patterns change.

496 Fact Level 2 *see also* C2.3

Urbanization is closely linked to industrialization. Nearly 75 percent of the US population lives in urban areas, as opposed to only 25 percent in India. The rate of urban growth, however, is much greater in the Third World.

497 Issue Level 2 *see also* C1.4

The rate of urbanization is rapidly increasing worldwide. Housing, water supply, waste disposal, and sewage treatment facilities have not kept pace. This has led to polluted, over-crowded living conditions for many who move to the city.

498 Definition/Issue Level 3 *see also* C1.4

Urban SLUMS are densely populated areas characterized by over-crowding, poverty and poor living conditions. Improving the capacities of cities to accomodate more people, and decreasing urban migration by making rural living more attractive (e.g., by creating new jobs and providing services in rural areas) are two approaches to countering slum growth.

499 Issue Level 2 *see also* C1.4

Over-crowding of people in cities can cause aggressive behavior, crime, deteriorated health and mental tension.

500 Opinion Level 3 *see also* C4.3

In human settlements, each of us is responsible for maintaining our environment so that it promotes the well-being of all.

Manufacturing & Technology C2.3

Definition	Level 1	<i>see also B1</i>	501
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TECHNOLOGY includes all the tools, including knowledge, that we use to extract resources from our environment.

Fact	Level 2	<i>see also C1.2</i>	502
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Humans have the technological ability to control their environment through production of energy, food and living space, control of other species, and so on.

Issue	Level 2	<i>see also B1.2</i>	503
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Technology can be applied to make more efficient use of known resources and to develop new resources. But it can also lead to accelerated use of these resources.

Fact/Issue	Level 2	<i>see also C1.3</i>	504
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Technology can have positive or negative effects on the environment. Recently developed technologies, such as strip mining, can severely damage the environment. Others, like pollution-control devices on industrial chimneys, can improve environmental quality.

Issue	Level 2	<i>see also B2.1</i>	505
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Technological activities of humans have increased energy consumption. Conversely, increased energy use has allowed the development of advanced technologies.

Issue	Level 3	<i>see also C1.3</i>	506
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Technological development has accelerated changes in the biosphere and led to the exploitation of environments previously not affected, such as deserts, swamps, polar ice caps, the sea bed, and tropical rainforests.

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| 507 | Issue | Level 2 | <i>see also B4</i> |
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- Industries stress the environment with the large quantities of materials and energy they use, and with the pollution they generate.
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|------------|-------------|----------------|----------------------|
| 508 | Fact | Level 3 | <i>see also B4.2</i> |
|------------|-------------|----------------|----------------------|
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- The scale of production has a large effect on the environment. Traditional craftsmen and artisans operate on a small scale, producing small amounts of waste which can usually be absorbed by the local environment. Large scale industries require special pollution control measures when disposing of their extensive and concentrated wastes.
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|------------|-------------|----------------|----------------------|
| 509 | Fact | Level 1 | <i>see also B2.2</i> |
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- Large quantities of water are essential for most manufacturing processes. The production of one kilogram (2.2 lb) of steel requires 250 kg of water, while the production of a kilogram of synthetic fiber requires 20,000 kg of water.
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| 510 | Issue | Level 2 | <i>see also B4</i> |
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- Some industries have passed on to society the environmental costs of production: air, water and noise pollution; loss of natural resources; and a deterioration of the aesthetic quality of the environment.
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| 511 | Issue | Level 3 | <i>see also B1.4</i> |
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- Mass manufacture through industrial processes has caused the loss of traditional jobs. Mass manufactured products are "cheap" because of the economics of scale (e.g, lower per-unit energy costs, reduced labor needs). But the environmental and social costs of mass production may be high.
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|------------|-------------|----------------|----------------------|
| 512 | Fact | Level 1 | <i>see also B1.3</i> |
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- Sometimes production waste from one industry can be the raw material for another. For example, sawdust, a waste product of wood products manufacturing, may be used to make paper board.
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Issue **Level 3** *see also B1.4* **513**

Inappropriate use of technology has resulted in diverse and major environmental problems (species extinction, radiation and chemical poisoning, wasted renewable and non-renewable resources) and social problems (unemployment, displacement, mass urbanization).

Definition **Level 2** *see also B1.4* **514**

APPROPRIATE TECHNOLOGY meets human needs with minimal long-term damage to the environment and maximum social and economic benefits to its users.

C3
Social
Systems

Economic Systems C3.1

Opinion **Level 3** *see also* C3.2 **515**

The earth is one but the world is not. Each nation strives for prosperity within its geographic boundaries, with limited regard for its impact on others.

Definition **Level 2** *see also* B1.2 **516**

ECONOMIC SYSTEMS are societal arrangements for exploiting resources and producing and distributing the goods and services that individuals and societies need or desire.

Fact/Issue **Level 2** *see also* C3.2 **517**

No country has all the resources it needs, so economic systems are tied together through world markets of raw materials, food, and manufactured goods. Thus economic events that occur in one country affect other countries (e.g., a crop failure in one country may generate higher prices for food products from other countries).

Fact **Level 2** *see also* B1.2 **518**

The state of the economy influences the rate of resource use. High rates of economic growth generally lead to greater use of resources, as per capita and overall consumption increase. Conversely, troubled economies may force countries to exploit natural resources with little regard to environmental or social costs.

Issue **Level 3** *see also* B1.4 **519**

Short-term economic gains often result in long-term environmental, social and economic losses. For example, large-scale hydroelectric projects may provide employment, electricity and water for irrigation, but often are not profitable in the long run, and usually cause significant environmental damage.

520 Opinion Level 2 *see also* C4.1

Environmental quality cannot easily be quantified using current economic terms, which are based on purely financial considerations.

521 Issue Level 3 *see also* B1.3

Environmental problems may be defined within an economic context. In the West they are often associated with protecting endangered species and wilderness for the sake of aesthetics and recreation. In many poorer nations, however, conserving the resource base is a matter of survival for millions of rural poor who depend on the environment for their sustenance.

522 Opinion Level 2 *see also* B1.2

People realize their needs from the environment according to their wealth. If we have more buying power, we will often consume resources to the extent our wealth allows.

523 Opinion Level 1 *see also* C4.1

People have needs and wants. Basic food is a need; a television set is a want. Most people do not have enough money to meet all of their needs and wants. Making wise decisions in purchases is both personally and environmentally important.

524 Issue Level 3 *see also* C3.2

Those who are poor and hungry may destroy their immediate environment in order to survive; they will cut down forests, overgraze their livestock, overuse marginal lands and crowd into already congested areas.

525 Opinion Level 2 *see also* C3.2

The livelihood and hopes of the poor are the first casualties of a degraded environment.

Opinion/Issue **Level 3** *see also* **B1.4** **526**

Economics is not just about producing wealth, and ecology is not just about protecting nature; they are both relevant in improving the quality of human life.

Sociopolitical Systems **C3.2**

Fact **Level 1** *see also* **C3.1** **527**

The people and nations of this world are interdependent.

Opinion **Level 2** *see also* **B1.2** **528**

Political instability in the world is based largely on the disproportionate distribution and control of resources within and among nations.

Fact/Issue **Level 2** *see also* **B1.2** **529**

Resources are uneven in distribution and accessibility not only among nations, but within nations. In each nation some levels of society have greater access to resources than others.

Fact/Issue **Level 3** *see also* **C4.4** **530**

Environment is an international concern. Atmospheric and ocean currents can carry pollutants to every part of the world, while overharvesting of migratory species and changes in climate are problems that transcend national boundaries. An example of an international environmental event is Chernobyl, where radiation from a damaged nuclear reactor in Russia contaminated dairy products in Europe which eventually were consumed by people as removed from the accident as Brazil.

531 Issue Level 2 *see also* C4.1

Environmental issues can cause conflict between individuals with different values, or because of differences between the wants of the individual and the environmental priorities of the society.

532 Issue Level 1 *see also* C4.3

Often people most affected by environmental abuses are neither responsible for bringing them about, nor able to correct the abuses.

533 Issue Level 2 *see also* C4.4

Regional, national and international economic and political decisions can result in major positive or negative impacts on the environment. Leaders should be chosen who understand the need for a healthy environment for all people.

534 Issue Level 2 *see also* C4.4

Some people and organizations have more power to influence environmental decisions than others. These "decision makers" should be informed of environmental problems and encouraged to pursue actions for rectifying the problems.

535 Fact Level 3 *see also* B1.3

Today conservation is on most governments' agendas. Four percent of the earth's surface has been set aside for management of its species and ecosystems.

536 Fact Level 2 *see also* B3

India is one of the few countries whose constitution makes specific reference to the need for nature and wildlife conservation. At present India has 53 National Parks and 247 Sanctuaries under the Wild Life (Protection) Act of 1972. India was also one of the first countries to have launched social forestry.

Culture & Religion C3.3

Opinion **Level 1** *see also C1.2* **537**

Our interplay with the natural environment is of central importance in the way we express ourselves in folklore, art, religion and customs.

Fact **Level 2** *see also C1.2* **538**

Human cultures evolved within specific environments. Just as evolution is a biological adaptation to the environment, culture is a social and behavioral adaptation.

Fact **Level 1** *see also C1.2* **539**

As humans learned to manipulate their environment, they moved in large part from simple cultures (hunter-gatherer) to more complex cultures (agricultural, urban).

Fact **Level 2** *see also C1.2* **540**

The wide variations existing in human cultures are intrinsically related to our interactions with our environment.

Fact **Level 2** *see also C1.1* **541**

Every culture has its own perceptions, conceptions and beliefs derived from its interaction with its natural surroundings.

Fact **Level 1** *see also C1.2* **542**

Dietary habits are strongly linked to environment and to culture. As balanced diets evolve in almost all cultural systems, no one dietary system can be said to be right or wrong.

Fact	Level 1	<i>see also</i> C1.1
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Different cultures and religions may have different conceptions as to the place of humans in the environment, including the proper use of resources.

Fact/Issue	Level 2	see also
		C4.1

The Judeo-Christian ethic gives humans responsibility for nature, God's creation. According to some, this has led to a tradition of exploiting nature to meet our needs. Faced with ecological crisis, we must learn to stress the duty to preserve, not exploit, the natural world.

Fact **Level 2** *see also* C4.1

Hinduism states that the natural environment is a manifestation of divine nature itself. "Dharma", part of the Hindu concept of religion, is a code of conduct for organizing lifestyles so they are harmonious with other people and with the environment.

Fact	Level 2	<i>see also</i> C4.1
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Buddhism, through its cardinal principles of simplicity and non-violence, has encouraged respect of ecological management and rational use of natural resources for satisfying man's material needs. Buddhists stress the relationship between humans and trees. They suggest planting a tree every few years and then keeping watch over it, to foster a personal relationship between the tree and the human.

Fact	Level 2	<i>see also</i> C4.1
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Islam stresses that God has full ownership of the land and that we are only trustees. The right to ownership of land which has been improved from barren to productive is stressed. A special emphasis is placed on the protection of fruit-bearing trees.

C4
Environmental
Awareness
and Protection

Fact **Level 3** *see also C4.1* **548**

In some instances religion has inspired environmental protection. The Bishnoi community in western India instructs followers never to cut a live tree or kill an animal. About 350 years ago, 363 Bishnois (including women and children) laid down their lives to prevent the local king from cutting down trees in their area. The tradition of preservation has continued, and even now the Bishnoi villages are refreshing scenes of greenery and wildlife in the Indian desert.

Fact **Level 3** *see also B3.3* **549**

In some Eastern religions, sacred groves (or lakes and rivers) are conferred protection under religious sanction. Such protection of entire biological communities has preserved biodiversity that otherwise has been lost in the same regions. Some groups also consider certain species sacred, leading to their protection and preservation.

Fact **Level 2** *see also B1.3* **550**

Often cultural practices sanctified by religion put restraints on the use of plant and animal species and so promote their conservation. Such practices include taboos on the killing of certain sacred species, closed seasons for hunting, and sacred areas where resource use is restricted or prohibited.

Fact/Issue **Level 3** *see also C1.2* **551**

Environmental degradation leads to the deterioration of not only natural systems, but also the cultural environment, as cultural conditions are dependent on natural surroundings.

Opinion **Level 2** *see also B1.3* **552**

Cultural resources in the form of historic buildings, monuments, arts, crafts and language should be preserved and maintained. Once lost, these rich ties with history and the environment cannot be easily restored.

Value & Ethics C4.1

Opinion **Level 1** *see also C4.3* **553**

Human behavior is a result of VALUES, which are reflections of our feelings of responsibility toward other people and the environment.

Fact **Level 2** *see also C3.3* **554**

Each culture has a hierarchy of values which dictates how it uses the environment. These values are often environmentally sound, emphasizing use of those resources readily available. For example, we prefer some foods over others, or homes built of wood, mud, stone or brick, depending on the resources at hand.

Definition **Level 2** *see also C1.2* **555**

ENVIRONMENTAL PERCEPTION derives from our constant communication with our environment. Perception is the synthesis of this communication, in which we internalize our surroundings, deriving meaning and values from them.

Definition **Level 1** *see also B1.2* **556**

There is a difference between QUALITY OF LIFE and STANDARD OF LIVING. The latter refers to our consumption of goods and services, which may or may not make us happier or healthier. The quality of life refers to our health and happiness, both related to the quality of our environment.

Issue **Level 2** *see also B1.4* **557**

Quality of life cannot be measured by any universal yardstick. Two societies may have very different standards of living, but the quality of life according to their cultural and social systems may be equivalent.

558 Issue Level 2 see also C2.3

Business and industry produce things people want or need. They can create a demand for their products through advertising. If people buy the product, the business profits and makes more products. If people reject a particular product, the business will stop making it. Thus the decisions of individuals influence business. Rejecting a product which harms the environment in its manufacture, use or disposal is a **VALUE DECISION**.

559 Opinion Level 1 *see also* C1.1

Nature is a key for self-discovery. Often, it is through our enjoyment of nature that we develop an "environmental ethic."

560 Opinion Level 2 *see also* C1.1

We are ethically responsible to other individuals and society, and to that larger community, the biosphere.

561 Opinion Level 3 see also C1.3

How our environment is affected by specific actions is a scientific question; what actions we ultimately choose is an ethical question, beyond the reach of science.

562 Opinion **Level 3** *see also* C1.1

If the human ability to alter the environment is combined with our ability to understand the environment, an ethic of accountability may be developed.

563 **Fact/Issue** **Level 3** *see also* B1.3

Conceptions as to the proper use of resources have changed throughout history. For example, in some cultures, exploitation of natural resources was acceptable when wilderness was vast and seemingly limitless. Today our conservation ethic reflects the realization that resources are finite.

Issue **Level 2** *see also* **B1.3** **564**

Conservation occurs when people recognize their responsibility to maintain the environment, and choose to become involved in this maintenance.

Fact **Level 2** *see also* **C3.3** **565**

Traditions in India teach that all forms of life--human, animal and plant--are sacred, and so closely linked that disturbance in one gives rise to imbalance in the others. Conservation is a reiteration of this attitude.

Opinion **Level 1** *see also* **C1.1** **566**

All living things in the biosphere have needs. People should respect the needs of fellow life-forms.

Opinion **Level 3** *see also* **C3.3** **567**

Learning more about people of other cultures and nations, and developing an attitude which values all peoples, is an important step in developing a world in which we all live in harmony with each other and our environment.

Opinion **Level 3** *see also* **C1.1** **568**

Each of us should live a life guided by respect for the earth and all living things, now and in the future.

Opinion **Level 3** *see also* **C4.2** **569**

Change in the human environment is often so rapid that information and values learned in childhood may no longer be valid in adulthood. We must be willing to accept new information and adopt new values to live in harmony with our environment.

570 **Opinion** **Level 3** *see also* **B1.2**

In the words of Mahatma Gandhi, "the world has enough for every man's needs but not for every man's greed."

571 **Opinion** **Level 1** *see also* **B3.2**

Wilderness is of intrinsic value, to be maintained for itself.

C4.2 **Education & Communication**

572 **Opinion** **Level 2** *see also* **C4.3**

Information and public education lead to the development of environmental concern and action.

573 **Definition** **Level 1** *see also* **C4.3**

ENVIRONMENTAL EDUCATION is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments and skills to work individually and collectively toward the solution of current problems, as well as the prevention of new ones.

574 **Opinion** **Level 2** *see also* **C4.4**

An environmentally literate country is more likely to adopt environmentally sound policies. Environmental education should reach all sectors of the population through the use of both formal and non-formal techniques.

Fact **Level 2** *see also C4.3* **575**

Mass media can play a pivotal role in the spread of environmental awareness, disseminating information on environmental problems and possible solutions. Media can act as a catalyst, spurring concrete action by government and non-government organizations, and by the public at large.

Fact **Level 2** *see also C4.3* **576**

Schools can play an important role in environmental education. Enthusiastic teachers have considerable influence over the children they teach. Environmental concepts can be taught in many ways, as part of standard curricula or in specific programs, indoors or outdoors, by teachers or by guest instructors.

Opinion **Level 1** *see also C3.3* **577**

Building on traditional knowledge is one of the most effective ways of teaching environmental concepts, especially to non-school audiences.

Fact **Level 3** *see also C1.1* **578**

The environment itself is the greatest instrument for environmental education. Any environment -- natural or artificial, the school ground or the rain forest -- provides a pool of information about resources, systems and interactions.

Opinion **Level 2** *see also C4.3* **579**

Public awareness and support promote action by city, district, state or central authorities. The success of environmental management depends largely on public support of environmental issues.

Opinion **Level 3** *see also C4.3* **580**

Adequate environmental knowledge is sometimes not enough to change behavior in individuals or populations. In many cases, economic circumstances or ingrained social patterns make planned change difficult or impossible.

581 **Opinion** **Level 3** *see also C4.4*

Establishing in our children a sense of their rich environmental heritage, which they must help to preserve, is more effective than just passing laws to protect resources.

C4.3 Participation & Voluntary Action

582 **Fact** **Level 1** *see also B1.3*

Sometimes the simplest measures go a long way in conserving natural resources (for example, shutting off lights when not in use).

583 **Issue** **Level 3** *see also C4.4*

It is imperative that governments adopt and enforce formal environmental policies, guidelines and standards. But government alone cannot solve all problems. Participation of individuals, communities and non-government groups is needed to foster environmental health.

584 **Opinion** **Level 2** *see also C4.2*

Public concern can restrain the enthusiasm of industry and government for taking up projects whose environmental connotations are not clear.

585 **Fact** **Level 3** *see also C4.4*

Environmental concern can promote and energize government action. Public concern can also bring about support to those in government who try to promote long-term views of ecologically sound economic and social development.

Fact **Level 2** *see also C4.4* **586**

Community and private organizations are important in creating government recognition of local environmental problems. Environmental organizations are concerned with all aspects of environmental quality, including policy, law, education and actions.

Opinion **Level 2** *see also B4.2* **587**

Neighborhood cooperation with the municipality to cope with problems like insanitation and congestion can prevent health hazards and improve the local environment.

Opinion **Level 1** *see also B1.3* **588**

We should not let personal or national wealth cause us to become more wasteful of resources. Salvaging and recycling resources (e.g., paper, steel scrap) should be something we do regardless of financial wealth.

Opinion **Level 2** *see also B1.3* **589**

We should be selective in our consumption of resources, choosing those which result in the least environmental damage in their extraction and use.

Opinion **Level 1** *see also C4.1* **590**

We should never needlessly damage or deface anything, or litter our surroundings.

Fact **Level 3** *see also C4.4* **591**

People with similar goals working together can often be more effective in influencing environmental decisions than individuals working alone.

Choosing life styles in harmony with the environment fosters long-term benefits to present and future generations.

Certain environmental problems are handled by government. These include international issues; problems which are too big or too costly to be undertaken by the private sector; the setting of regulations and the management of public resources.

In many cases it is necessary to change the law, or create new laws and regulations, in order to prevent or rectify environmental abuses.

Environmental policy is formed by the interaction of science and technology, social values, political factors, and aesthetic and economic considerations. Policies also arise from reactions to incidents (e.g., the Bhopal chemical disaster), according to people's changing attitudes and perceptions, and in response to scientific investigations.

To formulate effective environmental policy, accurate information is crucial.

Opinion **Level 3** *see also C3.1* **597**

Decisions affecting the environment should be made only after considering possible consequences of each alternative. Cost-benefit analyses should incorporate environmental and human considerations as well as financial profit.

Opinion **Level 2** *see also C3.2* **598**

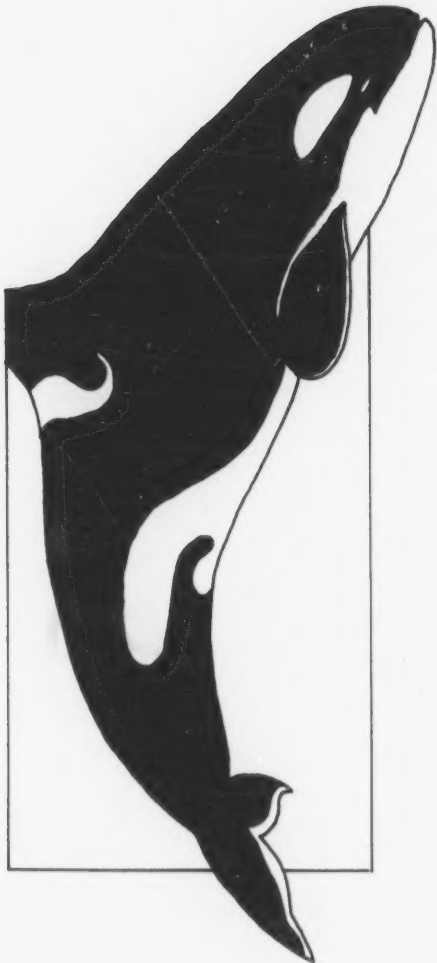
Environmental legislation should seek to improve the lives of people from all socio-economic classes.

Issue **Level 2** *see also B1.3* **599**

Laws protecting resources should not deprive the poor of their needs. People dependent on the land must be given alternative sources when their traditional resources are placed in protected areas.

Fact **Level 3** *see also C3.2* **600**

The ability of the legal system to uphold and enforce environmental laws and regulations depends heavily on public support, and whether prevailing laws and regulations are practical and enforceable.



Educator's Chart

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A1.1 Environment	1	•				•			•			
	2	•			•					•		
	3	•				•			•	•		
	4	•				•			•	•		
	5		•		•					•		
	6	•			•					•		
	7	•				•			•			
A1.2 Earth	8	•				•			•	•		
	9	•				•				•		
	10	•				•			•	•		
	11	•				•			•			
A1.3 Biosphere	12		•			•			•	•		
	13	•			•					•		
	14	•				•	•		•			
	15	•				•				•		
A2.0	16	•				•			•			
	17	•			•					•		
	18	•				•				•		
	19		•			•				•		
A2.1 Energy	20		•			•				•		
	21	•				•			•	•		
	22	•			•					•		
	23	•				•				•		
	24		•			•				•		
	25	•				•				•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A2.1 Energy (cont'd.)	26		•			•				•		
	27			•		•				•		
	28	•				•			•			
	29		•			•				•		
	30		•			•				•		
	31	•				•			•			
	32			•		•				•		
A2.2 Atmosphere	33		•			•				•		
	34	•			•	•				•		
	35	•				•				•		
	36		•			•				•		
	37			•		•				•		
	38	•				•			•			
	39		•			•				•		
A2.3 Land & Soil	40			•		•	•		•	•		
	41	•				•			•	•		
	42			•			•		•			
	43		•			•			•			
	44			•		•			•			
	45		•			•			•			
	46	•			•	•				•		
	47		•			•				•		
	48		•			•				•		
	49		•			•				•		
	50		•		•	•				•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A2.3 (cont'd.)	51	•			•	•			•	•		
	52		•		•	•				•		
	53		•			•				•		
	54	•				•				•		
	55		•		•	•				•		
A2.4 Water	56	•				•			•			
	57	•				•				•		
	58	•				•			•	•		
	59	•				•				•		
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	61		•		•	•			•	•		
	62		•			•				•		
	63	•				•				•		
	64	•			•					•		
	65		•			•				•		
A3.1 Biotic Components: Plants	66	•			•					•		
	67	•				•				•		
	68		•			•				•		
	69	•				•				•		
	70	•				•				•		
	71		•			•				•		
	72	•				•			•			
	73	•				•			•	•		
	74	•				•			•			
	75		•			•				•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A3.1 (cont'd.)	76			•		•				•		
	77		•			•				•		
	78	•				•			•	•		
	79	•			•					•		
	80		•		•	•				•		
A3.2 Biotic Components: Animals	81	•			•					•		
	82			•		•			•			
	83		•		•	•				•		
	84	•				•				•		
	85	•				•				•		
	86	•				•			•	•		
	87	•				•			•	•		
	88		•			•			•	•		
	89	•				•				•		
	90	•				•			•	•		
A4.1 Weather & Climate	91	•			•					•		
	92	•			•					•		
	93	•			•					•		
	94		•			•				•		
	95		•			•				•		
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	97		•		•					•		
	98		•		•	•				•		
	99	•				•	•		•			
	100			•		•			•			

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A4.2 Biogeochemical Cycles	101	•			•					•		
	102	•				•				•		
	103		•			•				•		
	104			•		•				•		
	105	•			•	•				•		
	106		•			•				•		
	107		•			•				•		
	108		•			•				•		
	109		•			•				•		
	110		•		•	•				•		
A4.3 Evolution & Extinction	111		•			•				•		
	112			•		•	•		•	•		
	113	•				•				•		
	114	•				•				•		
	115	•			•	•			•	•		
	116		•			•				•		
	117		•		•	•				•		
	118	•			•	•				•		
	119		•			•				•		
	120		•			•				•		
	121		•		•	•				•		
	122		•		•	•				•		
	123		•		•					•		
	124		•		•					•		
	125			•		•	•		•	•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A4.3 (cont'd)	126		•		•	•			•	•		
	127			•		•	•		•	•		
	128			•		•	•		•	•		
	129			•		•	•		•	•		
	130			•		•	•		•	•	•	
	131			•		•	•		•			
	132	•			•					•		
	133	•			•					•		
	134	•				•			•	•		
	135		•		•					•		
A5.0 Ecosystems	136		•			•				•		
	137		•			•				•		
	138			•		•				•		
	139		•			•			•	•		
	140		•		•					•		
	141		•			•				•		
	142			•		•				•		
	143			•		•			•			
	144		•		•	•				•		
	145	•			•					•		
A5.1 Food Chains & Webs	146		•			•			•	•		
	147	•			•					•		
	148	•				•				•		
	149	•			•	•				•		
	150	•			•					•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A5.1 Food Chains & Webs (cont'd)	151		•			•			•	•		
	152		•			•			•			
	153		•			•				•		
	154	•			•					•		
	155		•		•					•		
	156	•				•				•		
	157			•		•			•			
	158		•			•				•		
	159		•		•	•			•	•		
	160		•		•					•		
	161		•		•					•		
	162			•		•				•		
	163			•	•					•		
	164		•		•					•		
	165			•	•	•				•		
A5.2 Community	166			•		•				•		
	167		•		•					•		
	168	•				•			•			
	169		•		•					•		
	170			•		•				•		
	171			•		•				•		
	172		•			•				•		
	173			•	•	•				•		
	174			•		•				•		
	175		•			•				•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A5.2 (cont'd)	176		•		•	•				•		
	177		•		•					•		
	178			•		•	•		•	•		
	179	•			•					•		
	180		•			•				•		
A5.3 Population	181	•				•				•		
	182		•			•				•		
	183	•			•					•		
	184	•			•					•		
	185		•			•			•	•		
	186		•			•				•		
	187		•			•			•			
	188		•		•	•				•		
	189			•		•				•		
	190	•				•				•		
A5.4 Habitat & Niche	191		•		•					•		
	192	•			•					•		
	193	•			•					•		
	194		•		•					•		
	195		•			•			•			
	196	•			•					•		
	197	•			•					•		
	198		•			•				•		
	199		•		•					•		
	200		•			•				•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
A5.4 (cont'd)	201			•		•			•			
	202		•			•				•		
	203		•			•				•		
	204			•		•				•		
	205		•			•				•		
	206			•		•	•		•	•		
	207	•				•			•			
	208	•				•			•			
	209	•					•		•			
	210	•				•			•			
B1.1 Natural Resources (General)	211	•			•					•		
	212		•			•			•	•		
	213	•				•				•		
	214		•		•	•			•	•		
	215		•		•					•		
	216	•				•			•			
	217	•				•	•		•			
	218	•				•	•			•		
	219			•		•				•		
	220	•				•	•		•			
B1.2 Distribution & Consumption	221		•				•		•			
	222		•					•	•		•	
	223		•				•			•		
	224		•				•		•			
	225			•			•		•			

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
B1.2	226			•			•	•	•	•		
	227		•			•	•		•	•		
	228	•				•	•			•		
	229		•					•	•			
	230	•				•				•		•
	231	•					•		•			
	232	•						•	•		•	
	233		•			•			•		•	
	234		•				•	•	•		•	
	235	•						•	•			
B1.3 Management & Conservation	236		•					•	•		•	
	237		•		•		•			•		
	238	•			•					•		
	239		•				•	•	•		•	
	240		•					•	•			
	241			•			•	•	•			
	242			•			•		•		•	
	243			•	•					•		
	244			•			•			•		
	245		•					•		•	•	
B1.4 Sustainable Dev't	246		•					•			•	•
	247		•			•	•		•	•		
	248	•				•				•		
	249	•				•			•			
	250	•				•	•		•			

B2.1 Energy & Minerals

ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
	introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
251	•			•	•			•	•		
252		•			•			•			
253		•			•	•		•	•		
254		•			•			•			
255	•				•			•			
256			•			•		•			
257			•		•			•		•	
258	•			•	•			•	•		
259		•			•	•		•			
260	•				•			•	•		
261			•		•	•		•			
262		•				•		•		•	
263	•				•			•	•		
264			•		•			•		•	
265		•			•				•		
266			•		•	•		•		•	
267	•			•	•			•	•		
268		•		•	•			•	•		
269		•			•			•	•		
270	•				•			•	•		
271		•			•	•		•	•		
272			•			•	•	•		•	
273		•			•	•		•			
274		•			•			•	•		
275		•					•	•			

B2.1 (cont'd)

ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
	introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
276	•				•			•			
277		•			•	•		•	•		
278			•		•	•		•	•		
279		•			•				•		
280	•					•		•			
281		•				•		•			
282		•			•	•		•	•		
283		•				•		•			
284	•			•					•		
285		•				•		•	•		
286			•			•	•		•	•	
287	•			•	•				•		
288	•			•					•		
289	•			•					•		
290		•			•				•		
291		•		•					•		
292		•			•	•		•			
293		•		•					•		
294		•			•	•		•	•		
295	•				•			•			
296	•				•				•		
297		•		•					•		
298		•				•		•		•	
299			•			•		•		•	
300		•			•	•		•	•		

B2.3 Land & Soil

ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
	introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
301		•			•			•			
302			•			•	•	•		•	
303	•				•			•			
304			•			•		•		•	
305			•				•	•		•	
306		•					•	•		•	•
307		•					•	•			
308	•				•				•		
309			•		•	•		•		•	
310	•					•		•			
311	•				•			•			
312		•			•	•		•	•		
313		•			•	•		•	•		
314		•			•	•			•		
315			•		•	•		•	•		
316			•				•	•			
317	•				•			•			
318		•			•	•		•	•		
319		•			•			•			
320	•				•				•		
321	•				•			•			
322		•			•	•		•	•		
323	•				•			•			
324		•			•	•		•	•		
325	•					•		•			

B2.3 Land & Soil (cont'd)

B3.1 Forests

ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
	introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
326	•				•				•		
327		•			•				•		
328			•		•			•	•		
329		•			•				•		
330		•			•				•		
331		•				•		•			
332	•				•			•	•		
333			•			•		•		•	
334		•		•		•		•		•	
335		•		•					•		
336		•					•	•			
337		•			•				•		
338			•			•		•			
339	•			•				•	•		
340		•				•		•		•	
341	•				•				•		
342		•			•	•		•	•		
343		•			•	•		•	•		
344			•			•		•			
345		•			•	•			•		
346			•		•			•	•		
347			•		•			•			
348		•			•				•		
349		•			•			•			
350		•		•		•			•	•	

B3.1 Forests (cont'd)

B3.2 Wildlife & Fisheries

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
B3.2 Wildlife & Fisheries (cont'd)	351			•			•			•	•	
	352			•		•	•		•	•		
	353		•				•		•			
	354			•			•		•	•		
	355		•			•	•		•	•		
	356		•		•	•				•		
	357			•		•	•			•		
	358		•			•	•		•	•		
	359		•			•			•	•		
	360	•			•					•		
B3.3 Biodiversity	361	•				•			•			
	362		•			•				•		
	363			•			•		•		•	•
	364	•			•					•		
	365		•				•		•	•		
	366		•			•	•		•	•		
	367		•			•			•			
	368		•				•		•			
	369		•			•			•			
	370	•				•			•			
B4.1	371			•				•	•		•	
	372			•		•			•	•		
	373		•			•				•		
	374		•		•	•				•		
	375			•		•	•		•			

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
B4.1 Limits to Systems	376		•				•	•	•		•	
	377		•			•	•			•		
	378			•		•	•		•	•		
	379			•		•	•		•	•		
	380	•			•					•		
	381		•			•				•		
	382	•			•					•		
	383	•				•				•		
	384		•		•					•		
	385		•			•				•		
B4.2 Pollution	386		•			•			•			
	387		•			•	•		•			
	388		•		•	•				•		
	389		•			•				•		
	390		•		•					•		
	391		•			•	•			•		
	392		•			•			•			
	393		•			•	•		•			•
	394		•			•				•		
	395	•			•	•				•		
	396		•			•				•		
	397		•			•				•		
	398			•		•				•		
	399		•		•					•		
	400			•		•	•		•	•		

ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
	introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
401		•		•	•				•		
402			•		•	•		•	•		
403			•		•	•		•	•		
404	•					•		•			
405			•		•				•		
406			•				•	•		•	•
407	•				•	•		•	•		
408			•		•	•		•			
409	•				•	•		•			
410	•					•		•			
411		•			•			•			
412		•				•		•		•	
413			•		•			•	•		
414			•		•	•		•			
415	•				•			•			•
416		•				•		•		•	
417			•				•	•			
418			•				•	•		•	
419	•						•	•		•	
420		•			•	•		•	•		
421	•				•			•	•		
422			•				•	•		•	
423		•				•		•			
424	•						•	•		•	
425		•			•	•		•			

B4.2 Pollution (cont'd)

C1.1 Humans/part of env.

ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
	introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
426		•					•	•			
427	•				•			•			
428		•			•				•		
429			•		•	•		•	•		
430			•				•	•			
431	•				•			•			
432	•				•			•			
433		•			•	•		•			
434		•			•			•			
435			•			•		•	•		
436		•			•	•		•			
437		•				•		•	•		
438		•			•	•		•	•		
439			•			•		•			
440	•						•	•		•	
441		•			•	•		•			
442	•					•		•			
443			•		•			•			
444			•				•	•		•	•
445		•			•	•		•			
446		•			•				•		
447		•				•		•			
448			•			•		•	•		
449		•			•	•		•	•		
450		•			•			•			

C1.2 Adaptation

C1.3 Human influence upon environment

C1.4 Population factors

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
C2.0 C1.4 (cont'd)	451			•			•		•		•	
	452			•		•	•		•	•		
	453			•		•	•			•		
	454			•			•		•			
	455		•			•	•			•		
	456	•				•			•	•		
	457		•			•			•	•		
	458		•			•			•	•		
	459		•			•	•		•	•		
	460			•		•	•		•	•		
C2.1 Agriculture	461		•			•				•		
	462	•					•		•			
	463		•			•				•		
	464			•		•	•			•		
	465		•				•		•			
	466			•			•	•	•	•		
	467		•			•	•		•	•		
	468		•			•	•		•			
	469		•			•	•		•	•		
	470	•					•		•			
	471			•	•	•				•		
	472			•	•					•		
	473	•				•			•	•		
	474	•				•			•	•		
	475			•		•	•		•	•		

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
C2.1 (cont'd)	476			•		•	•		•	•		
	477			•		•				•		
	478	•				•	•		•			
	479			•				•	•		•	
	480	•			•					•		
	481		•			•			•			
	482		•			•				•		
	483		•					•	•		•	
	484		•					•	•			
	485			•				•	•		•	
C2.2 Settlements	486		•			•				•		
	487	•				•				•		
	488			•				•	•			
	489		•			•			•			
	490		•		•					•		
	491			•		•	•		•	•		
	492			•		•	•			•		
	493	•				•				•		
	494		•				•		•			
	495		•				•	•	•			
	496		•			•			•	•		
	497		•				•		•			
	498			•	•		•		•	•		
	499		•				•		•			
	500			•				•			•	•

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
C2.3 Manufacturing & Technology	501	•			•					•		
	502		•			•			•			
	503		•				•		•			
	504		•			•	•		•	•		
	505		•				•		•			
	506			•			•		•			
	507		•				•		•			
	508			•		•			•			
	509	•				•			•	•		
	510		•				•		•			
C3.1 Economic Systems	511			•			•		•	•		
	512	•				•			•	•		
	513			•			•		•			
	514		•		•					•		
	515			•				•	•			
	516		•		•					•		
	517		•			•	•			•		
	518		•			•			•	•		
	519			•			•		•			
	520		•					•	•			
	521			•			•		•			
	522		•					•	•			
	523	•						•	•		•	•
	524			•			•		•			
	525		•					•	•			

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
C3.2 Sociopolitical Systems	526			•			•	•	•		•	
	527	•				•			•			
	528		•					•	•			
	529		•			•	•		•			
	530			•		•	•		•	•		
	531		•				•		•			
	532	•					•		•			
	533		•				•		•		•	•
	534		•				•		•		•	
	535			•		•				•		
	536		•			•				•		
	537	•						•	•			
	538		•			•				•		
	539	•				•				•		
	540		•			•			•			
C3.3 Culture & Religion	541		•			•			•			
	542	•				•			•	•		
	543	•				•			•			
	544		•			•	•		•			
	545		•			•			•			
	546		•			•			•			
	547		•			•			•			
	548			•		•				•		
	549			•		•			•	•		
	550		•			•			•			

	ENTRY NUMBER	LEVEL			CLASS				OBJECTIVE			
		introductory	intermediate	advanced	definition	fact	issue	opinion	awareness	knowledge	attitude	participation
C3.3	551			•		•	•		•			
	552		•					•	•		•	•
	553	•						•	•			
	554		•			•			•			
	555		•		•				•			
	556	•			•				•		•	
	557		•				•		•		•	
	558		•				•		•			•
	559	•						•	•			•
C4.1 Values & Ethics	560		•					•			•	
	561			•				•	•			
	562			•				•	•			
	563			•		•	•		•			
	564		•				•		•			•
	565		•			•			•		•	
	566	•						•	•		•	•
	567			•				•	•		•	•
	568			•				•			•	•
	569			•				•	•		•	•
C4.2 Education	570			•				•			•	
	571	•						•			•	
	572		•					•	•		•	
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